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MASTERY OF OUTER SPACE IN THE USSR, 1957-1967

G. A. Skuridin, Editor

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The volume contains material on space-rocket subject, connected with the mastering of cosmic space by the Soviet Union, published in Central news-papers from 1957-1967.

All the material of the volume is collected into several chapters, reflecting the main trend of cosmic investigations.

The publication is designed for a wide circle of readers.

Responsible editor G.A. Shuridin

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MASTERY OF OUTER SPACE IN THE USSR 1957-1967
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1975

C O N T E N T S

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FOREWORD:

The first decade of cosmic era was a grand epic of man's courage, unprecedented in enterprise and unique in its scientific and technical results.

The first artificial satellite of the Earth, first flight to the Moon and transmission to the Earth of the photographs of its invisible side, the first soft landing on the surface of the Moon, the first satellites of the moon, flights to Mars and Venus, the first smooth descent in the atmosphere of planet Venus of the automatic apparatus, the first flight of man into cosmos, the first exit of man into cosmic space. No epoch has ever known such a majestic upward flight of science and technique!

The Soviet people, their scientists and engineers have inscribed a brilliant page into the treasury of international culture and the progress of the whole mankind.

The Socialist Society have opened immense possibilities for a tempestous development in every sphere of modern science.

In our country there is a great number of scientific research and designing institutes, capable of resolving the most complex problems of the modern astronautics. The Communist Party of the Soviet Union is extremely interested in the development of the most foward trends in cosmic investigations, gives all possible assistance to daring projects of the Soviet scientists and engineers.

One of the outstanding pioners of space-research was the notable scientist of our country Academician S.P. Korolev, under whose leadership many space-rocket systems and space apparatus have been constructed.

Many Institutes of the Academy of Sciences of USSR and its scientists have greatly contributed to the study of cosmology and of the planets of Solar System.

The obtained data have revolutionized out concepts regarding the circumterraneous cosmic space, physical properties of the Moon, planets, Mars and Venus regarding properties of the interplanetary space.

At present by means of cosmic devices it has become possible to study a great number of physical processes, occurring in the Universe, from the elementary particles to gigantic sources of energy, such as Quasars, radio-waves from the Galaxy, flare up of Supernovas, the colossal energy of which is generated in the form of electromagnetic radiation, flux of relativistic particles, magnetic fields of high intensity and kinetic energy of ejected gas.

Cosmic investigations are undergoing "period of storm and rush". There are heated scientific discussions, continuous appearance of new facts and new ideas.

We are coming closer to understanding the nature's marvels: aurora borealis, magnetic storms, earth radiation belt. A picture of grandeur is uncovering in front of us of physical manifestations, apparently, interrelated, but distinct in such properties and diversity of processes, that the only wåy to unravel all the mechanisms of their origin is the simultaneous study of all the manifestations as a whole.

Perceptible on the Earth is the echo of a cosmic storm of enormous blasting force, which is caused by the effect of solar wind on the geomagnetic field and upper atmosphere.

The magnetic field of the Earth becomes deformed and localized in a certain region of circumterraneous space, known as the magnetosphere of the Earth, and on the night side of the Earth forms a gigantic magnetic tail, extending beyond the Moon's orbit. The magnetosphere and the magnetic tail are full of charged particles of different energy, which, interacting with geomagnetic field, specify many geophysical phenomena.

All this has become possible to study due to launching of artificial earth satellites or a whole system of satellites, as for instance, cosmic system "Electron".

Step-by-step the cosmic and rocket technique have armed the scientists with a multiform arsenal of means for investigation of cosmic space and the Solar system planets.

It is well known, what gigantic technical erections are the accelerators of charged particles. These accelerators are constructed in many countries for studying physics of elementary particles. Deeper penetration into the mysteries of the matter's structure requires enormous energy of particles. In cosmic space there is a existence of particles with energies of hundreds thousands milliards of electric volts. Construction on Earth of accelerators with these energies is at present practically impossible.

Soviet scientists have developed scientific equipment capable of recording particles of cosmic rays of superhigh energies directly in the cosmic space. A series of these experiments is the launching of "Proton" satellites, by means of which it was possible to obtain a number of major scientific results on the physics of cosmic rays and interaction of superhigh energy particles with nuclei of various atoms.

The use of cosmic technique has permitted to advance investigations of the interplanetary medium to a considerable extent.

In the region, investigated by means of interplanetary sondes, i.e. between the orbits of Venus and Mars and in the vicinity of ecliptic, there is a constant flux directed approximately from the Sun of charged particles, known as the

Solar wind, with density usually of a few particles in a cubic centimeter and velocity 300-500 km/sec. The ionic component consists of protons and, apparently, helium nuclei (alpha-particles) with concentration 10 times less. There are preliminary indications on the presence of once-ionized helium, although its presence in the solar wind is difficult to explain - in the solar corona it is not present (there the helium is completely ionized), and the number of the particles collision in the interplanetary medium is so low, that once-ionized particles should not be formed. The characteristics of the electronic component are still hardly known.

Besides the directed velocity, the flux particles have chaotic velocities, which represents in the temperature of medium in the range from thousands to hundreds of thousands of degrees.

The flux of solar plasma carries with it magnetic field. This magnetic field is extremely weak - abou one ten-thousandth of the field's intensity on the Earth. However, it is known, that it is highly significant in the transmission of interaction both in the interplanetary medium itself and between the plasma flux and the Solar System planets. The lines of force of the magnetic field have on an average the form of an Archimedean screw due to the fact, that the plasma produces the magnetic field approximately radially from the revolving Sun. Now the study begins of the fi e structure of the interplanetary medidum - individual recently discovered magnetic fibers, disturbances, and also of shock waves, propagating within the interplanetary medium after the origination of active processes on the sun.

Outstanding results were obtained in the study of the Moon and the planets Mars and Venus.

The automatic stations "Luna-9" and "Luna-13" have made it possible to "examine" in direct vicinity the microstructure and surface properties of the Moon. It was found, that the strength of lunar ground was sufficiently high to withstand the weight of automatic stations. Smooth descent of the "Venera-4" station into planet's atmosphere made it possible to obtain direct experimental data on chemical composition, density and temperature of the atmosphere of Venus. All these investigations open cut a new era in astronomy - the era of experimental astronomy.

At present the obtained data permit to formulate also certain general problems and prospects of investigations. This primarily pertains to the Moon, the study problem of which could be divided into three interconnected aspects of investigations:

a) structure of the lunar interior and the processes occurring therein;

b) composition and structure of the Moon's surface and their transformation;

c) history and evolution of the Moon.

These aspects of investigation are applicable to all the objects of planetary or subplanetary dimensions of the Solar System. As regards the Moon, the special interest is presented by the processes, relating not only to its surface, but are general for the Solar System, for instance, collision of solid bodies and charged solar corpuscles, physical recording of these effects, specially for the early period in the history of solar System. The fact, that old rocks and deposits on the surface of the Moon could serve as basis for the chronology of events, relating to formation and accretion of the Earth group planets, imparts a special significance to the Moon's investigations. Since the geological processes, which change the surface of the Moon are, probably, much slower, than the geological processes on the Earth, the part of lunar stratigraphic evolution reflects the early history of the Solar System, which, naturally, cannot be discovered on the Earth.

The main object of the geological investigations of the Moon is the study of the past of this planet and of the Solar System, in which it exists. The basic point in this time prospect is to define the stratigraphic succession (order), in which deposits of the past were accumulating. The difficulty of resolving this problem on the Earth is specified by the fact, that as a result of active orogenesis, erosion and formation of sedimentary rocks even the least noticeable remnant of the initial Earth structure happens to be destroyed. At present there is practically nothing known (at least nothing concrete) of the first billion of years of the Earth's existence.

The moon's surface could be one of the few places, where the earliest stratigraphic evidence has been preserved and is possible of being decoded. And because of the nearness of the Moon to the Earth a more detailed study of the Moon's structure is possible with the same out lay efforts, than the study of the geological structure of another nearest planet of the Earth group. Events recorded on the Moon are to a great extent similar to events on the Earth. Investigation of the Moon's origin makes it possible to elucidate the question regarding the common history of the Moon and the Earth. The comparison of the Earth and the Moon could resolve many basic problems of the Earth.

At present the chemical evolution of the Earth's crust complicated as a result of transformation by surface waters is not quite clear. The Moon may serve in this respect as an example of uncompleted evolution. The processes of orogenesis on the Earth are only partially comprehensible, since the tectonically active regions are covered by oceans or thick sedimentary series of rocks. As regards the Moon the tectonic deformation of the planet's surface could be studied without the masking effect of erosion, formation of sedimentary rocks or oceans. In the same way volcanic producecs, contaminated on the Earth by transition through chemically transformed surface deposits, on the moon should be quite free of these effects.

Thus, besides satisfying the natural interest to composition and history of the Moon, its study may be extremely important from the viewpoint of cosmology and comprehension of the main problems of the morphology of the Earth and of the Solar System as a whole.

Study of the Moon's shape, distribution of the substances, within it, heat flow from the Moon's interior and its magnetic field extends our knowledge of the composition and history of the Earth-Moon system.

In other words, problem of the Moon's investigation is inseparably bound with the problem of studying the Earth as one of the planets in the Solar System.

Highly significant from the viewpoint of understanding the origin and evolution of the whole Solar System and the Earth are, in particular, investigations of other planets, primarily Venus and Mars. Investigations of Mars are of interest also from the biological point of view, as it is precisely on this planet that the discovery is most probable of at least elementary forms of life.

But the important prospects of investigations are bound not only with investigation of the celestial bodies of the Solar System, but al with the study of the Sun itself, with the study of interplanetory medium and those flows of Solar plasma, which are recorded in the circumterraneous and interplanetary space.

The interplanetary matter - is the outermost portion of the Solar corona. The acceleration of the coronal substance upto velocities of the Solar wind occurs with the heating of corona, and to elucidate the acceleration mechanism - means to resolve one of the main questions in physics of the solar corona - its heating upto such high temperatures.

The interplanetary matter is one of the main factors, determining the state of the outer layers of the mantle of planets and, in particular, of the Earth. If in the streamlining of the Moon by solar wind the particles are simply absorbed by the lunar surface, with the streamlining of the magnetic field of the Earth its outer areas are deformed, there is formation of magnetic tail, and the variability of the flux and its magnetic field causes on the Earth magnetic storms, Aurora Borealis and other important geophysical phenomena. The streamlining by solar wind of Venus is entirely different - this planet does not have its own appreciable magnetic field and the only obstacle for the flow of plasma is the ionosphere of the planet.

The interplanetary medium is the medium, within which propagate cosmic rays, in particular, solar cosmic rays and, since the cosmic space has become the activity sphere of a man and his devices, the conditions of the propagation of particles with dangerous radiation must be known, so as to devise protection against them.

Finally, the interplanetary matter is a natural laboratory, where the physicists may study processes, occurring in the highly varified, collision-free plasma, in conditions, which in some respects are unattainable on the Earth.

Thus, we are right at the start of investigations of the most interesting events, occurring within the Solar System and in the Universe.

But the pursuit of astronautics is not only the purely scientific aims. Even now it is possible to speak of the immense possibilities of using cosmic space in applied and agricultural problems.

Everybody knows, how variable is the weather at all the latitudes and what a complex problem it is to forecast it. In aid to meteorologists came satellites, which have become the cosmic eye, surveying our planet. All changes, occurring in the cloud system, shifting of cyclones and other meteorological processes, are immediately transmitted by the satellites to Earth.

At present we have in our country a global cosmic system "Meteor", by means of which an effective checking of the meteorological conditions on our planet is conducted.

The communication satellites have opened a new chapter in the transmission of information between the continents, have connected, so to say, by a direct channel of radio and television the most distant corners of the Earth. "Molniya" satellites jointly with ground stations of "Orbita" system ensure in our country continuous communication between the most remote towns, including the Extreme North.

In future, by means of satellites it will be possible to set up service for prevention of forest fires, service, by means of which it will be possible to provide fishermen with the most appropriate points for fishing in seas and oceans, help geologists in the search for useful minerals, to assure constant observation of solar "weather".

Cosmic investigations is a gigantic stimulus of scientific and technical progress. Only a country with an extensive scientific and technical potential is capable of launching satellites and piloted space ships, flights to other planets. It is sufficient to say, that all this requires high perfection of control systems, radio-communication for hundreds of millions of milometers, new systems of navigation, production of material capable of operating in a deep vacuum and to withstand gigantic temperatures, creation of calculating technique for a most precise ballistic estimates and flight control of cosmic apparatus.

Man, his searching mind, his indestructible desire to penetrate the mysteries of the Universe daringly, step-by-step attacks the vast cosmic spaces. Let us recall the inspired words of K. E. Tsiolkovsky, founder of the modern astronautics: "Earth is the cradle of reason, but one cannot live for ever in a cradle".

It may be said with assurance, that Man will uncover many mysteries in the make up of the Universe. And all this will be harnessed for the service to Man, progress and culture of mankind.

The present volume includes communications of TASS, editorials, articles of the most outstanding scientists. Newspaper headlines are slightly modified in accordance with requirements of book publications. A portion of the articles text and some figures were omitted due to restricted volume of the book; a number of photographs was given from the photochronic of TASS.

G. A. Skuridin,

Dr. of Phys.-Math.-Sciences.

I. SATELLITES OF SCIENTIFIC DESIGNATION:

Communication of TASS regarding launching of the artificial satellite:

For a number of years in the Soviet Union research and experimental designing work is being carried out for the construction of an artificial Earth satellites. As informed in the press, the first launching of satellites in the USSR was to be implemented in accordance with the program of scientific investigations of the International Geophysical Year.

As a result of intensive work of Research Institutes and Designing Bureau the construction was completed of the first in the world artificial Earth satellite. The successful launching of the first satellite was carried out in USSR on the 4th October 1957. According to preliminary data, the carrier-rocket has communicated to the satellite the required orbital velocity of about 8000 metres per second. At present the satellite is describing an elliptical trajectories around the Earth, and its flight could be observed in the rays of rising and setting Sun by means of the simplest optical instruments (binoculars, telescopes, etc.),

According to calculations, which are being made now more precise by direct observations, the satellite will be moving at an altitudes of about 900 km above the surface of the Earth; the time of one full revolution of the satellite will be 1 hr. 35 min.

angle of dip of the orbit to equatorial plane 65°. On 5th October 1957 the satellite will pass twice over the area of Moscow - 1.46 a.m. and 6.42 a.m. Moscow time. Communications regarding subsequent movement of the first artificial satellite launched in USSR on the 4th October, will be transmitted regularly by radio broadcasting stations.

The satellite has the form of a sphere 58 cm in diameter and 83.6 kg in weight. It is fitted with two radio-transmitters continuously emitting radio-signals with frequency 20.005 and 40.002 megacycles (wave length about 15 and 7.5 metres respectively). The power of transmitters provides for an assured reception of signals by a wide circle of radio-amateurs. The signals are in the form of telegraph messages lasting about 0.3 sec., with a pause of the same duration. The sending of one frequency signal is implemented during the pause of another frequency signal.

The scientific stations, located at various points of the Soviet Union, continuously observe the satellite and determine the elements of its trajectory. Since the density of the rarefied upper layers of the atmosphere is not known exactly, there is no data available at present for exact determination of the existence time of the satellite and the point of its re-entry into dense layers of the atmosphere. Calculations have shown, that due to extremely high velocity of the satellite it will get burnt due to the dense layers of the atmosphere when it will attain an altitude of a few scores of kilometres.

In Russia as far back as the end of the XIX century the possibility of cosmic flights was first scientifically based due to the work of an outstanding scientist K.E. Tsiolkovsky.

The successful launching of the first Earth satellite, created by man, is a great contribution to the international science and culture. The scientific experiment at such a great level has an enormous value for comprehending the properties of cosmic space and the study of Earth as a planet of our Solar System.

During the International Geophysical Year the Soviet Union proposes to carry out launching of several more artificial satellites of the Earth. These following satellites will be of a larger overall dimensions and greater weight and will be used for carrying out an extensive program of scientific investigations.

The artificial Earth satellites will pave the way to interplanetary travel and may be, our contemporaries will witness, how the free and conscious labor of people in the new, socialist society makes real the most audacious dreams of mankind.

"Pravda", 5th October 1957.

SOVIET ARTIFICIAL EARTH SATELLITE:

4th October 1957 the whole world witnessed an outstanding event - the successful launching in the Soviet Union of the first artificial Earth satellite.

Communication regarding the launching of the satellite was received in every corner of the globe. Its transition was recorded by many observers in every Continent. The creation of the satellite was the result of long persistent scientific and design work, in which a large numbers of Soviet scientists, engineers, industrial workers participated.

Theoretically the question regarding the possibility of sending space ship beyond the atmosphere of the Earth was resolved at the beginning of the twentieth century by an outstanding Russian scientist, K. E. Tsiolkovskii, who proved, that the means for cosmic flight should be the rocket. K. E. Tsiolkovskii has worked out a number of cardinal problems of the interplanetary flight and pointed out, that creation of an artificial Earth satellite will be the first and necessary step.

The construction of the artificial Earth satellite required resolution of a number of most complex and principally new scientific and technical problems. The greatest difficulties were encountered in the development of the carrier-rockets for placing the satellite into orbit. Constructed for the launching of satellite is a carrier-rocket of high constructive perfection. Powerful motors were constructed, capable of operating in difficult thermal conditions. Optimum conditions were worked out for the rocket's motion, assuring its most effective use. To ensure the present law of the rocket's movement, required for placing satellite into orbit, a very precise and effective system of automatic rocket control has been developed.

Resolution of these, and also of many others most complex problems was found to be possible only as a result of using the latest achievements of science and technology in the most diversified spheres and primarily due to the high technical level of rocket-construction in USSR. The creation of artificial Earth satellite in such a short time was assured by a high level of Scientific and technical potential in our country, precise and organized work of Research Institutes, Design Departments and Industrial Undertakings.

The launching of the satellite was preceeded also by extensive experimental work, connected with construction and production of individual units, as well as of the whole system in one set.

The successful launching of the satellite fully confirmed the correctness of the estimates and the basic technical decisions, taken in the construction of the carrier rocket and of the satellite.

The launching of the first satellite opens out an extensive program of scientific investigations, which will be continued during the International Geophysical Year on a number of the subsequent artificial satellites, the construction of which envisages greater dimensions and weight. The creation of a satellite is the first step in the conquering of the interplanetary space and realization of cosmic flights.

The satellite has the shape of a sphere. It was placed in the front part of the carrier-rocket and closed by a protective cone. The rocket with the satellite was started vertically. A little while after the start by means of programing device the rocket's axis began to deviate gradually from the vertical direction. At the end of the section for placing into orbit the rocket was at an altitude of several hundreds of kilometres and was moving parallel to the earth surface at a velocity of about 8000 m/sec. When the work of the rocket's motor was completed, the protective cone was thrown off, the satellite separated from the rocket and began moving independently.

At present moving around the Earth is a satellite equipped with devices, as well as the carrier-rocket and protective cone. Since the separation speed of the cone from the satellite and of satellite from the rocket is not very high, the carrier and the cone were for sometime at a comparatively short distance from the satellite, revolving around the Earth along the orbits, near to that of the satellite. Thereafter, due to the difference in periods of revolution, resulting from the relative speed at the instant of separation, as well as from the different degree of braking in the atmosphere of the Earth, all the three bodies diverged and in the process of further movement may happen to be at one and the same time above entirely different points of the earth's surface.

Satellite orbit:

The orbit of the satellite represents in the first approximation an ellipse, one of the foci of which is in the center of the Earth. The altitude of the satellite's flight above the surface of the Earth does not remain constant, but changes periodically, attaining its peak - approximately thousands of kilometres. At present the perigee of the orbit is in the northern hemisphere of the Earth, and the apogee - in the southern hemisphere.

The orientation of the orbit's plane in relation to stationary stars remains almost constant. Since the Earth revolves around its own axis, then with each subsequent turn the satellite should be above a different area, shifting during one turn approximately 24° in longitude. The actual displacement in longitude will be slightly greater, as due to deviation of the graviational field from a central one, the plane of the orbit will be gradually turning around the Earth's axis in a direction opposite to its rotation. This movement of the orbit's plane is not very great and adds upto about a quarter of a degree in longitude during one revolution. As a result of the relative movement of the Earth and the orbit's plane each subsequent turn will be more westerly than the preceeding at the latitude of Moscow by about 1500 km. In the equatorial region the displacement is greater and will compose about 2500 km.

The plane of the orbit is dipping toward the plane of the earth's equator at 65°. In this connection the path of the satellite passes above the areas of Earth, located approximately between the Northern and Southern polar circles. Due to Earth's rotation around the axis the angle of dip of the path to equator is distinct from the dip of the orbit's plane. Coming into the northern hemisphere the path interesects the equator at an angle of 71.5° in direction the north-east direction. Then the path gradually turns more eastward and, touching parallel, corresponding to 65°N, deviates southward and intersects the equator in N-E direction at an angle of 59°. In the southern hemisphere the path touches parallel, corresponding to 65° S, thereafter deviating northward and again passes into the northern hemisphere.

In time, due to the braking of satellite in the upper layers of the Earth's atmosphere, the shape and the size of the satellite's orbit will gradually change. Since at the high altitude, where the satellite is moving, the density of atmosphere is extremely low, the evolution of the orbit will be very slow initially. The altitude of apogee will decrease faster than that of perigee and the orbit will progressively approach circular. With the re-entry of the satellite into denser layers of the atmosphere the braking will be very powerful. The satellite will become red hot and will burn similar to meteors, arriving from the interplanetary space and burning in the Earth's atmosphere.

At present the density of the upper atmosphere is not known exactly. Therefore to forecast precisely the time remaining for the satellite in the orbit does not seem to be possible so far.

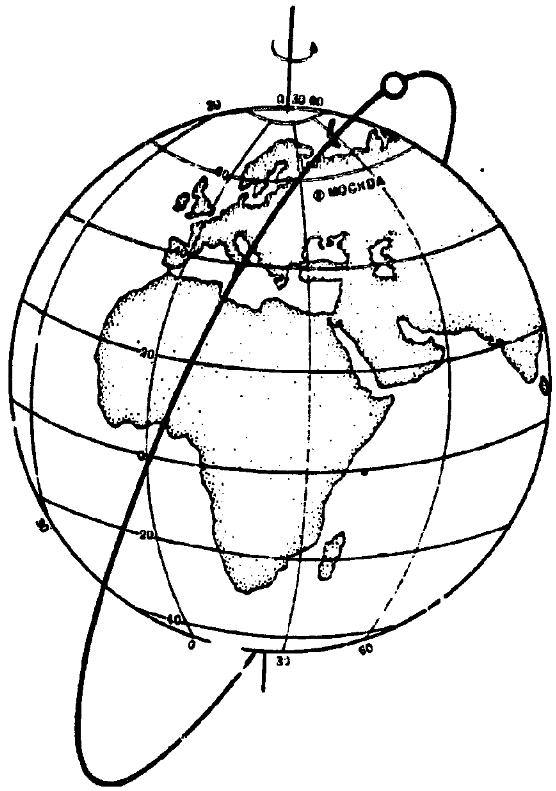

Fig. 1 - Satellite's orbit.

Data available at present in regard to density of the upper atmosphere, and also the results of trajectory measurements make it possible to assert, that the satellite will keep on moving around the Earth for quite some time.

The period of the satellite's revolution is at present 96 min. With the lowering of orbit the period will decrease. The changing rate of period will be indication of the rate of the change in the orbit's shape. Therefore the exact measuring of the satellite's revolution period is an extremely important and responsible problem.

The parameters of the orbit of the Soviet artificial satellite permit to observe it in all the continents in a wide range of latitudes. This opens out extensive possibilities for resolving various scientific problems. It may be pointed out, that the launching of the satellite into this orbit is a more difficult problem, then the launching into an orbit close to equatorial plane. With the launching along the equator there is a possibility of using to a greater extent the speed of the Earth's rotation around the axis for the speeding up of the rocket.

Observations of the satellite's movement.

A very important component of investigations, being conducted by means of the artificial Earth satellite, is the observation of its motion, processing of observations and forecasting from the results of processing further movement of the satellite. Observation of the satellite is being conducted by means of radio-technique, and also in observatories by means of optical instruments. Besides the specialists with their means for observation a wide circle of radio-amateurs has been attracted, as well as groups of amateur astronomists, which conduct observations from astronomical platforms by means of optical instruments specially made for this object. At present observations of satellite in USSR is being conducted regularly by 66 stations of optical observations and 26 clubs DOSAAF with a great number of means for radio observations. Moreover, the satellite is being observed individually by thousands of radio-amateurs.

The scientific stations conduct observations by means of radio-locators and direction finders. Also by optical methods and photographing the movement of the satellite.

Let us pause on the methods of observation by astronomers and radio amateurs, since these methods are available to a wide circle interested in the movement of the satellite. The astronomists-amateurs have a large number of specially made astronomical telescopes with perfect optics and a wide vision angle. The observation stations also have equipment sets, which permit to determine the position of the satellite in the celestial sphere at any moment.

The available apparatus, by means of which the optical station marks the position of the satellite in the celestial sphere, permits to carry out measurements with accuracy upto one degree, and the moment, when this position was marked, with an error of not over one second. The optical station observes the satellite in the morning or in the evening, when the surface of the Earth is in darkness, whereas the satellite, being at high altitude is lightened upby the Sun.

It should be mentioned, that observations of the satellite by means of astronomical instruments are rather difficult and are not resemblin observations of the usual astronomical objects, since the satellite is moving in the sky very fast, with the speed on an average of about one degree per second.

To ensure reliable observations each optical station arranges one or two "optical barrier" out of telescopes, located

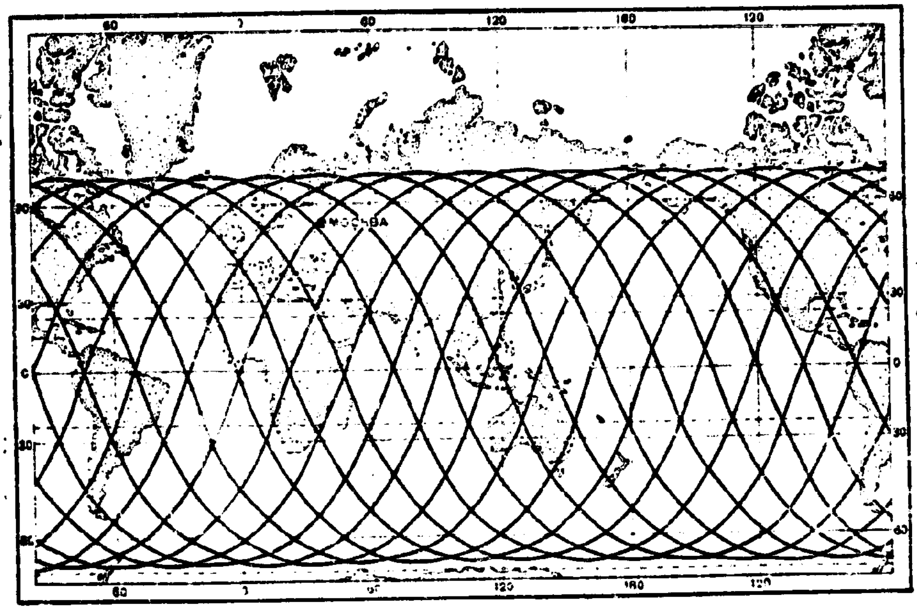

Fig. 2 - Movement pattern of the satellite during 24 hrs.

in meridian and along the vertical circle, perpendicular to the visible orbit of the satellite. Moreover, in the search of the satellite the application is of the method, based on the so called "rule of the local time". This method uses the fact, that the orbit of the satellite does not participate in diurnal rotation of the Earth, and the satellite itself will pass through preset latitude at the local sidereal time, gradually changing with rotation of the orbit in absolute space around the earth axis due to deviation of the gravitational field from the central field. Because of this the satellite in the process of its movement will pass for the given station through sequence of points in the celestial sphere, which could be denoted as points of expectation. If the axis of the optical instrument is adjusted in a way, so that it will be directed at the prevously estimated in the celestial sphere the next expectation point, then it is inevitable that sometime or other the satellite will be discovered.

Observations of the satellite is being conducted by a great number of radio-amateurs by means of radio-receivers specially constructed for this purpose. Diagrams of these receivers, as well as the diagrams of direction-finding attachments were published in the Popular Science Radio-Technical journal "Radio" long before the launching of the satellite. Information regarding the movement of the satellite, issued to radio-amateurs, could be used not only for the study of transition laws of radio-waves through the atmosphere, but also, specially in the case if the radio-amateur is using direction-finding attachment, for the rough elements determination of the satellite's orbit.

Even now a great amount of the satellite's observations by radio-amateurs is available. At a number of points the passage of the satellite was recorded by amateur astronomists. At a number of points, unfortunately, the overcast sky did not make it possible until now to conduct optical observations.

All data of scientific stations, and also radio and optical observations by amateurs are collected and processed. As a result the determinations, both of the orbit's elements and of their secular departures, are made. The application in processing is made of the latest electronic computers. As a result of processing the parameters of the orbit are made more precise and the forecasting of the satellite's movement is done. Moreover, data received from the observation stations are used for a number of geophysical investigations, conducted by means of the satellite, such as for instance, density determination of the atmosphere from parameters evolution of the satellite's orbit.

Specifications of the satellite:

As pointed out previously the satellite has the shape of a sphere. Its diameter is 58 cm, weight - 83.6 kg. The air-tight body of the satellite is made from aluminium alloys. The surface is polished and specially treated. The whole apparatus of the satellite with power-packs of instruments are arranged within the body. Prior to launching the satellite is filled with nitrogen gas.

On the outer surface of the body are fitted antenna in the form of rods 2.4 - 2.9 m in length. At the time of the satellite's coming out the antenna rods are pressed to the rocket body. After separation of the satellite the antenna turn on their hinges.

In moving along the orbit the satellite is periodically subject to sharply variable heat effects - heating by Sun rays during its presence above the lightend up side of the Earth, cooling while flying in the shadow of the Earth, theremal effects of the atmosphere, etc. Moreover, a certain amount of heat is exhausted in the satellite from the working of instruments. In respect to the heat the satellite is an independent celestial body, which has heat exchange through radiation with the surrounding space. Therefore to assure for a long period normal temperature conditions in the satellite, required for the working of its instruments, is a principally new and a rather complex problem. Maintenance of the required temperature conditions in the first satellite is provided by imparting to its surface corresponding values of radiation and absorption of solar radiation factors, and also by the control of heat resistance between the sheath of the satellite and the apparatus within it through forced circulation of nitrogen within the satellite.

Two radio-transmitters are set up in the satellite, which continuously emit signals with frequency 20.005 and 40.002 megacycles (wave-length 15 and 7.5 m respectively). It should be mentioned, that in the artificial satellite constructed in USSR, due to its relatively high weight, it was possible to set up radio-transmitters of high power. This permits to receive signals from the satellite at very considerable distances and makes it possible for a large circle of radio-amateurs in all parts of the world toswitch-on to the satellite. The first 24 hrs of observations of the satellite's flight confirmed the possibility of assured reception of its signals by ordinary amateur receivers at distances of several thousands of kilometres. Individual cases were fixed, when the signals of the satellite were received at distances upto 10,000 km.

Radio-signals of the satellite:

Radio-signals emitted by radio-transmitters on each of the frequencies are in the form of telegraph messages. Sending of signal of one frequency is produced durin the signal pause of another frequency. Duration of signals on each of the frequencies composes on an average about 0.3 seconds. These signals are used to observe the satellite's orbit, and also for resolving a nu ber of scientific problems. For the recording of processes, taking place in the satellite, sensitive elements are set up on it, which change frequencies of the telegraph sending and ratio between duration of sending and pauses, when there is change of some parameters on the satellite (temperature etc.). On reception of signals from the satellite they are recorded for subsequent decoding and analysis.

It should be taken into account, that after some time radio-transmitter will cease operating. For instance, it may happen, if a meteoric particle pierces the body of the satellite or damages the antenna. Moreover, the satellite will be observed by optical methods and by radio-locators.

Highly significant are the observations of the propagation of radio-waves, radiated from the satellite. Until now basic information regarding ionosphere was obtained by the study of radio-waves, sent from the Earth and reflected by the ionospheric regions, lying below maximum ionization of ionospheric layers. At present it is actually unknown, at what altitude lies the upper boundary of ionosphere. The launching of the satellite makes it possible to obtain for quite sometime radio-signals with two different frequencies from regions of ionosphere, hitherto inaccessible for long observations, lying above ionization peak, and may be, generally above the ionosphere.

Level measuring of received radio-signals and refraction angles of radio-waves with different frequencies enables to obtain data regarding the attenuation of radio-waves in previously uninvestigated regions of ionosphere and some information regarding the structure of these regions.

The program of scientific measurements on the artificial Earth satellites is very extensive and covers many sections of physics of the upper layers of atmosphere and the study of cosmic space close to the Earth.

These sections include the study of the condition of ionosphere, its chemical structure, pressure and density gauging, magnetic measurements, study of the nature of corpuscular radiation of the Sun, primary composition and variation of cosmic rays, ultraviolet and X-ray regions of the solar spectrum, and also electrostatic fields of the upper layers of the atmosphere and microparticles. Even the first satellite will provide information on a number of these questions.

In the sphere of cosmic rays study the program envisages obtainance of data on the relative quantity of various nuclei in the composition of the primary cosmic radiation. In particular, determination will be carried out of the relative quantity of lithium, beryllium and born nuclei, and also of heavy nuclei. In this respect it will be possible to obtain data, unattainable for the hitherto applied investigation methods.

The equipment, which is being fitted on the satellites, enables also to study variations in the complete flux of cosmic rays, investigation of which is hampered by the great thickness of the atmosphere above the instruments, when these are set up on the Earth. The obtained data will enable to define diurnal, semi-diurnal and twenty-seven-day variations and to study their connection with pehnomena on the Sun. The satellite enables to carry out the indicated measurements throughout the Globe.

Due to absorption by the atmosphere of the solar short-wave radiation is still unknown. The high altitudes, at which the satellite is circulating, will enable by means of the instruments, developed by our physicists, to study the ultraviolet and X-ray regions of the solar spectrum and to define variations in radiation intensity. This is important, since in accordance with the present day concepts the short-wave radiation of the Sun causes ionization of the atmosphere's upper layers. Therefore these results will shed new light on the formation processes of ionosphere. Since the short-wave radiation of the Sun is caused by the solar corona, data on this radiation will enable to obtain new results on the structure of the solar corona.

Besides the short-wave radiation of the Sun an immense role in processes, occurring in the upper layers of the atmosphere, is played by corpuscular radiation of the Sun. Therefore, it is important to decide the question regarding the nature of corpuscular radiation, its intensity, energy spectrum of particles ejected by the Sun, and to elucidate the role of the Sun's corpuscular radiation in the formation of the northern lights. These questions will also be possible to resolve with the help of equipment, set up in the artificial Earth satellites.

The flight of the satellite above the ionized layers of the atmosphere enables to check a number of deductions, made on the basis of one or another hypothesis, regarding cyclic currents existing in the upper layers of the atmosphere. Artificial satellites will enable also to study the quick variation of the Earth's magnetic field.

There is a considerable interest in studying at great altitudes (about 1000 km) of electrostatic fields and resolution of the question as to whether the Earth with its atmosphere is charged or a neutral system. Besides the study of ionosphere by indirect methods just observing the transition of radio-waves the program of investigations on the satellite envisages direct gauging of ionic concentration at various altitudes, and thereafter also of the chemical composition of ionosphere by mass-spectrometry. If the present concepts are true regarding the absence at high altitudes of negative ions, these tests will provide full information about the composition of ionosphere.

Without pausing on all the scientific investigations, which are and will be conducted in the artificial satellites during the International Geophysical Year, we would mention also the investigations of meteoric matter present in the upper layers of the atmosphere. The delimination of the mass spectrum and velocities of microparticles, falling into atmosphere from the cosmic space has been earmarked.

Artificial satellite is the first step in the conquering of cosmic space. For transition to cosmic flights with man the effect should be studied of the cosmic flight conditions on live organisms. First these should be done on animals. The same as it was in altitude rockets a satellite will be launched in the Soviet Union, carrying on board animals as passengers, and detailed observations of their behavior and of the course of physiological processes will be conducted.

It may be said with assurance, that implementation of the planned program of scientific investigations by means of the artificial Earth satellites will revolutionize many problems of physics, geophysics and astrophysics.

With the successful launching of the artificial Earth satellite the science and technology are making a new jump ahead, transferring direct investigation methods into cosmic space unattainable till now and paving wide ways for the future interplanetary travelling.

"Pravda", 9th October, 1957.

TASS COMMUNIQUE

REGARDING THE LAUNCHING OF THE SECOND ARTIFICIAL EARTH SATELLITE

In accordance with the program of the International Geophysical Year for scientific investigations of the atmosphere's upper layers, and also the study of physical processes and conditions of life in cosmic space the launching was carried out on the 3rd of November in the Soviet Union of a second artificial Earth satellite.

The second artificial satellite, constructed in the USSR, is the last stage of the carrier-rocket with containers within it of scientific instruments.

The following is contained on board of the second artificial satellite:

- instruments for investigating solar radiation within the short-wave ultraviolet and X-ray regions of the spectrum;
- instruments for the study of cosmic rays;
- instruments for studying temperature and pressure;
- air-tight container with test animal (dog), air-conditioning system, food store and instruments for studying life activity in conditions of cosmic space;
- measuring instruments for transmitting data of scientific gauging to the Earth;

- two radio-transmitters, operating on frequencies 40.002 and 20.005 megacycles (wave-length about 7.5 and 15 metres respectively);
- the required power packs.

Total weight of all the apparatus, test animal and power packs adds upto 508.3 kg.

According to observations the satellite received orbital velocity of about 8000 m/sec..

According to estimates, which are being made more precise by direct observations, maximum distance of satellite from the Earth surface is over 1500 kilometres; the time of one complete revolution is about 1 hr, 42 minutes; the dip or orbit to equator plane is approximately 65°.

According to measurements data, being received from board of satellite, function-ing scientific instruments and checking of the life-activity of animal is quite normal.

Above the area of Moscow the second artificial satellite has passed twice - at 7 hrs. 20 minutes and at 9 hrs 05 minutes Moscow time.

Signals of the satellite's radio-transmitter on frequency 20.005 megacycles are in the form of telegraph sending with duration of about 0.3 seconds with pause of the same duration. Radio-transmitter on frequency 40.002 megacycles operates in conditions of continuous emission.

By the successful launching of the second artificial Earth satellite with diverse scientific instruments and test animal the Soviet scientists are expanding investigations of the cosmic space and upper layers of the atmosphere. The unknown processes of the nature's phenomena, occuring in the cosmic space, will become now more attainable to the man.

Collectives of Research Institute, Design Departments, testers and industrial plants, who constructed the second artificial Earth satellite, dedicate its launching to the 40th anniversary of the Great October Revolution.

"Pravada", 4th November 1957.

THE SECOND SOVIET ARTIFICIAL EARTH SATELLITE

As communicated in the press, in accordance with the plan of scientific work, conducted in accordance with the program of International Geophysical Year, the Soviet Union has launched on the 3rd of November 1957 the second artificial Earth satellite. This is another outstanding success of the Soviet science. The intensive and fruitful work of the large collectives of scientists, engineers, technicians and labourers has made it possible to construct and place into orbit a satellite, the efficient weight of which adds upto 508 kilograms 300 grams, which is 6 times the weight of the first satellite. Moreover the second satellite was placed into orbit considerably more distant from the surface of the Earth, than that of the first satellite.

The second artificial satellite is equipped with various scientific instruments, which would enable to carry out an extensive program of investigations. There are instruments for the study of cosmic rays, investigation of ultraviolet and X-ray matter of solar radiation, an air-tight cabin with a test animal (dog), radio-telemetric apparatus for transmission to Earth of the measuring results, radio-transmitters as well as the required power sources.

The satellite's orbit and its evolution:

The placing of the second satellite into orbit was done by means of a compound rocket. In the process of placement into orbit the rocket rised to an altitude of several hundreds of km from the Earth's surface; at the end of the placement section its last stage was moving parallel to the Earth's surface at velocity of over 8000 m/sec., having converted into the Earth's satellite. At the moment of exit into orbit the fuel supply in the tanks of the rocket was exhausted, and the motor was switched-off. Further movement of the satellite continued due to kinetic energy, acquired in the speeding-up of the rocket at the point of placement.

Velocity communicated to the last stage of the rocket was greater than the velocity required for the moving of the satellite along the circular orbit at constant altitude, corresponding to the point of exit into orbit. Therefore the satellite is moving not along the circular orbit, but along the ellip-tical, the furthest distance of which from the Earth is about 1700 km, which is almost double the maximum altitude, attained with the launching of the first satellite. Since the dimensions of the major semi-axis of the second satellite orbit are greater, than of the first satellite, the period of its revolution around the Earth was also greater and was at the start of the movement 103.7 minutes.

Due to the increased period of revolution the second satellite completes about 14 complete revolutions around the Earth in 24 hrs., whereas the first satellite completed during the initial period of movement about 15 revolutions. The shifting of each next turn in longitude due to diurnal variation in the Earth's rotation is 1/15 greater for the second satellite than for the first. The distance on the Earth's surface between the two adjucent turns has increased to the same extent.

Resistance of the Earth's atmosphere causes braking of the satellite. Its orbit with this changes its dimension and shape Due to the fact, that the atmosphere at high altitudes is extremely rarefied the retarding force acting on the satellite is not high. Therefore, the change in the orbit's parameters is very gradual. Since the density of the atmopshere quickly decreased with altitude, the retardation is mainly in the region of perigee, i.e. in the region, adjacent to the point of the least distance from the Earth's surface. At the point of apogee, i.e. at the point of the maximum distance, the satellite is moving at an altitude, which places it in cosmic space, outside the limits of earth atmosphere, which according to theoretical data extends to an altitude of about 1000 km above the Earth's surface.

The retarding of the satellite depends not only on the density of atmosphere, but also on the shape of the satellite and on the ratio of its weight to cross-sectional area (the so called cross-sectional load). With high cross-sectional load the loss in velocity will be less.

Two satellites, placed initially into the same orbit, but with a different retarding force, will be moving after some time differently, as their orbits will vary at different rate. In this case the reduction in dimensions of orbit will occur mainly due to decreasing height of apogee.

The first satellite and its carrier-rocket were moving initially approximately along the same orbit, the period of their revolution differed negligibly and composed about 96.2 min. At present, due to the fact, that the extent of the first satellite's retarding is less, than of the carrier-rocket, their orbits differ considerably. The apogee of the carrier-rocket is lower than that of the satellite by more than 100 km. The revolution period of the carrier-rocket, according to the data of the 10th November, was less than the revolution period of the first satellite by about 74 seconds.

The retarding force both of the carrier-rocket and of satellite is time-dependent due to the changing parameters of the orbit. With decline of the orbit the retardation progressively increases. This fact is clearly confirmed by the results of the observations. With the drop of the orbit to altitudes of about 100 km the retardation will be so considerable, that there will occur intensive heating of the satellite and carrier-rocket, their further fast drop and burning.

The existence time of the satellite depends on its retarding force in the atmosphere. Obviously, the greater is the period of revolution and the lower is the retarding force, the longer will be the existence time of the satellite. Calculations, carried out on basis of data, obtained from the observations of the first satellite and carrier-rocket, make it possible to assume, that the time of the satellite's existence should be about three months, counting from the moment of launching. This means, that the first satellite will exist in the orbit, apparently, till the end of 1957. The existence time of the carrier-rocket is less than that of the first satellite. Therefore it should be expected, that the carrier-rocket will get burnt before the satellite. Higher revolution period of the second satellite and lower retardation force than of the first, permits to assert, that the orbital time of the second satellite will considerably exceed that of the first satellite.

Processing of trajectory measuring results will enable to fix the entire evolution process of the orbital parameters and to obtain important information regarding density distribution in the upper layers of atmosphere. In future it will be possible to issue reliable forecasting on the existence time of the artificial Earth satellites.

Observations of the artificial Earth satellites:

In optical observations of the motion of the two first satellites and the carrier-rocket there is a regular participation of 66 special stations of optical observation, every astronomical observatory of the Soviet Union, and about 30 foreign observatories. At present a network is being organised of optical stations in countries of People's Democracies. The number of foreign astronomical observatories, participating in regular observation of the artificial satellites increased day-by-day. The intense luminosity of the carrier-rocket and of the second satellite enabled to draw-in to visual observations also the aerological points of the Hydrometeoservices, which have sphere-piloting theodolites.

As a result of optical observations it was clarified, that the carrier-rocket changes its luminosity. This is due to the change in its orientation in space. The shortest visually recorded period of the change in luminosity composes about 20 seconds.

Besides the visual there are also photographic observations of the carrier-rocket and of the second satellite. Photographs, obtained in Pulkovskii observatory, in the observatory of the Astrophysical Institute of the Academy of Sciences of Kazakhskii SSR, in observatory of Kharkov State University and other astronomical Departments of the Sovet Union, as well as the photographs made in observatory "Purple Hill" (Chinese People's Republic), Edinburgh observatory (Great Britain), Dansink observatory (Eire), Potsdam observatory (GDR), etc., enabled to make considerably more precise the orbits of satellites and carrier-rocket.

A very extensive material is being provided by the radio-observations of the artificial Earth satellites. These observations were conducted at points, located in different geographical latitudes and longitudes, direction-finder stations, DOSAAF clubs, a number of universities and thousands of radio-amateurs. The obtained material is so extensive, that at present it is only tentatively processed.

Measurement of the field intensity of radio-signals, received from the satellite, are highly significant. These measurements were implemented by continuous automatic recording, as well as by individual measurements at fixed times. The results enable to evaluate the absorption of radio-waves in ionosphere, including those of its regions, which lie above peak ionization of the main ionospheric layer F_2, and are therefore unattainable to the usual measurements, conducted from the surface of the Earth. These measurements permit to judge also of the possible propagation paths of the radio-waves in ionosphere.

Results of the radio-signals from satellite and the measuring of their level show, that these signals on 15-meter wave were received at very great distances, far in excess of direct visibility distance. These distances reach 10, 12 and even 15 thousand kilometres, and in some cases even more.

Of special interest is the fact, that the satellite,moving along the elliptical orbit, takes up different position in relation to the main peak of electronic concentration in the Earth's atmosphere. In processing of radio material it was taken into account, whether the satellite at a given moment is higher or lower than the true altitude of the maximum electronic concentration of layer F_2, obtained on basis of high-frequency characteristics of ionosphere, recorded by ionospheric stations. If in the Southern hemisphere the satellite moves above the ionosphere, then in the Northern hemisphere it is at some moments above the maximum ionization of this layer, at other moment - below it, and at some moments above the maximum ionization of this layer, at other moments - below it, and at some moments - in the vicinity of this maximum. These conditions create high divergence in the propagation paths of short radio-waves to considerable distances. One of these paths is the reflection from the Earth surface of radio-waves, transmitted downward through the whole thickness of ionosphere, with subsequent single reflection from ionosphere in those of its regions, where the critical frequencies are quite high. In other cases radio-waves, incident from above at some angle on to ionosphere, are considerably refracted within it and penetrate as a result into the region, lying beyond the limits of the direct geometrical visibility.

The position of the satellite in the vicinity of the maximum ionization region of the atmosphere builds-up specially suitable conditions for the propagation of radio-waves through ionospheric wave-guides. In some cases, as shown by the observations, radio-waves arrived at the point of reception not by the shortest distance, but around the globe along the major arc of the great circle. Observed in some cases was the phenomenon of around-the-world echo of radio-signals. In some cases the measured values of the field intensity were found to be higher than the calculated by inverse-square law, which also indicates the presence of wave-guide in ionosphere.

Interesting results were obtained from observation of the Doppler's effect by recording on magnetic tape the changes in the beat between the frequency of radio-waves, emitted by the satellite, and oscillations frequency of local heterodyne. A great amount of these recordings was obtained and their results are being processed.

Undoubtedly, final processing of the radio-observation material of the artificial Earth satellite will provide valuable data regarding the ionization of the upper regions of ionosphere, and also regarding the absorption and the nature of propagation of radio-waves with in them.

The arrangement of the second satellite:

As pointed out above, the second Soviet artificial Earth satellite, in distinction from the first satellite, is the last stage of the rocket, arranged in which is the whole of the scientific and measuring instruments. This arrangement of the apparatus has appreciably simplified the problem of determining the coordinates of the satellite by means of the optical observation, since, as shown by the experience of the first satellite, observations of the carrier-rocket were much simpler, than of the satellite itself, Luminosity of the carrier-rocket exceeds that of the first satellite by several stellar magnitudes. The total weight of the apparatus, under-test animal and power sources on the second satellite adds up to 508 kg 300 g.

In the front part of the last stage rocket, fitted on a special frame is the device for investigating radiation of the Sun and the ultraviolet and X-ray regions of spectrum, spherical container with radio-transmitters and other instruments, hermetically-sealed cabin with the under-test animal - dog. The apparatus for studying cosmic rays is located on the rocket's body. The instruments fitted on the frame and in container are protected from aerodynamic and thermal effects taking place in the flight of the rocket through the dense layers of the atmosphere, by a special protective cone. After the last stage of the rocket was placed into orbit, the protective cone was thrown-off.

Radio-transmitters in the spherical container operated on frequencies 40.002 and 20.005 megacycles. Their power sources, thermoregulating system and the sensitive elements, which record variation of temperature and other parameters, are also arranged in the same container. The spherical container is similar in its construction to the first Soviet artificial Earth satellite.

The signals of radio-transmitter, which operated on frequency 20.005 megacycles (wave-length 15 metres), were in the form of telegraph sendings. Their duration, just as the pause between them composed on an average about 0.3 seconds. With the change of some parameters in the container (temperature, pressure) duration of sendings and pauses between them varied in definite limits.

Radio-transmitter on frequency 40.002 megacycles (wave-length 7.5 m) operated in conditions of continuous emission. Setting up of two radio-transmitters on the pointed out frequencies assured carrying out of investigations on the propagation of radio-waves, emitted from the satellite, and parameters measuring of its orbit. Moreover, this assured reception of signals from the satellite in any state of the ionosphere. The selection of the wave-lengths and the sufficient power of the radio-transmitters enabled a very wide circle of radio-amateurs to conduct radio-observations of the satellite side-by-side with the special sations.

The hermetically-sealed cabin with the dog has a cylindrical shape. In order to create conditions, required for the normal existence of the animal, it contained a store of food and air-conditioning system, consisting of regeneration unit and thermoregulating system. Moreover, the cabin contained instruments for recording of pulse, respiration, blood pressure electro-cardiograph, and also sensitive elements for gauging a number of parameters, characterizing conditions in the cabin (temperature, pressure).

The animal's cabin, same as the spherical container, is made from aluminium alloys. Their surface is polished and specially treated to impart the required values of luminosity and absorption factor of solar radiation. The heat regulating systems, fitted in the spherical container and in the animal's cabin, maintained temperature within the preset limits, removing heat to the sheath by the forced circulation of gas.

Besides the mentioned instruments, set up on the body of the rocket's last stage were the radiotelemetric apparatus, temperature gauging apparatus, power sources for scientific and gauging apparatus. Temperature of the outer surface and inside the animal's cabin, as well as the temperature of individual instruments and construction details was determined by means of temperature gauges, set up on them. The radiotelemetric apparatus transmitted to the Earth all the measuring data, obtained on the satellite. It was switched on for transmission of data periodically according to a special program.

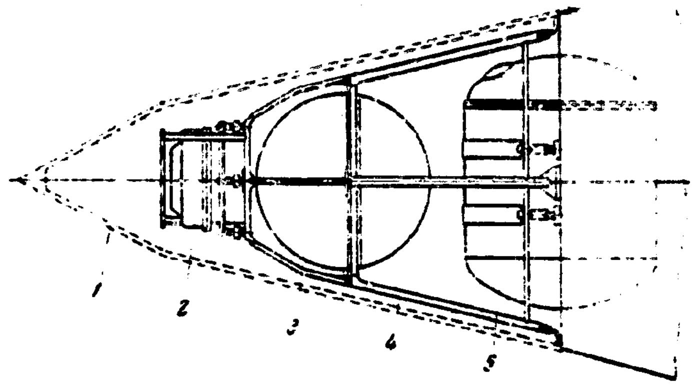

Fig. 3 - Diagram of the apparatus arrangement.

1 - protective cone, thrown off after the satellite is placed into orbit;

2- device for investigating ultraviolet and X-ray radiation of the Sun;

3- spherical container with instruments and radio-transmitters;

4- force frame for attachment of apparatus;

5- hermetically-sealed cabin with the animal.

The program of scientific investigations, connected with measurements on the second artificial satellite, was estimated for seven days. At present the program has been implemented. Radio-transmitters of the satellite, as well as the radio-telemetric instruments on board have ceased their operation. Further observations of the second artificial Earth satellite for the study of the characteristics of the atmosphere's upper layers and forecasting of the satellite's movement are being conducted by means of optical means and direction finders.

Scientific measurements in the Artificial Earth satellite:

The artificial Earth satellite has enabled the scientists to implement for the first time a number of tests in the upper layers of ionosphere, which was previously impossible.

Short-wave radiation of the Sun:

Of paramount interest both scientific and practical to physicists, astrophysicists and geopysicists is the investigation of short-wave ultraviolet radiation of the Sun. As shown by investigations of the recent years, the Sun, besides the visible light, emits radiation, extending into wide-range of wavelength, starting from X-rays with wavelength of about hundred-millionth of a centimeter and ending by radio-waves of several meters in length.

Emission of the short-wave end of the solar spectrum (distant ultraviolet and X-ray radiation), and also radio-emission is bound with physical processes, which take place in little-known external layers of the solar atmosphere (chromosphere and corona), and have a most critical effect on the atmosphere of Earth. The main study of the Sun's chromosphere is concentrated in the spectral line of hydrogen with wave length 1.215 Angstrom (1 Angstrom 1 hundred millionth part of cm), located in the distant ultraviolet region of the spectrum, and the radiation of corona - in the region of soft X-ray (3-100 Angstrom). The corona, which is composed of very rarefied matter, has temperature of almost one million degrees, moreover it, apparently has regions with even higher temperature. The nature of corona still remains to a considerable extent mysterious.

The total energy of the short-wave radiation of the Sun is comparatively low - it is tens of thousands times less than the energy, radiated by the Sun in the visible light, however, it is precisely this radiation, which has an extremely high effect on the Earth's atmosphere. It is explained by the fact, that short-wave radiation has extremely high activity and is capable of ionizing air molecules, causing formation of ionosphere - highly ionized upper layers of atmosphere. According to existing concepts, the bottom layer of ionosphere, which lies at an altitude of 70-90 km(D layer), is formed by the ionization of air molecules by the radiation of the hydrogen spectral line, emitted by the chromosphere, and the next layer - at an altitude 90-100 km (E layer) - by the X-ray radiation of corona.

The state of the upper layers of the Sun and ionosphere does not remain constant - it continuously changes. The presence of a close relationship between the activity of the Sun - appearance of the so called chromospheric flares and absorption of radio-waves in ionosphere, resulting in interception of radio-communications is confirmed. This forces to assume the existence of direct relationship of intensity variations of the short-wave radiation of the sun with processes in ionosphere.

The Earth's atmosphere completely absorbs the ultraviolet radiation of the Sun, passing through only the nearest ultraviolet radiation region, adjacent to the violet edge of the visible spectrum. This absorbing action of the Earth's atmosphere protects the live organisms from the radiation of the Sun fatal to them short-wave. At the same time it prevents the investigation of the radiation on the Earth. The absorption by air molecules is so great that for the observation of this short-wave radiation it is necessary to be completely beyond the limits of the Earth's atmosphere, by placing the instruments into the artificial Earth satellite. Although the application of high-altitude rockets produced valuable results, it is only the use of the satellite which makes it possible to conduct systematic measurements for long periods of time, required for the study of variations in the intensity of the short-wave ultraviolet radiation.

Radiation receivers are the three special photoelectric multipliers, arranged at an angle of 120 degrees to each other. Every photomultiplier is successively covered by several filters of thin metallic and organic films, and also of special optical material, which enables to separate various bands in the X-ray spectrum of the Sun and the line of hydrogen in the distant ultraviolet region. Electric signals, emitted by photomultiplier directed at the Sun, were amplified by radio-circuits and transmitted to the Earth by means of the telemetric systems.

Due to the fact that, the satellite continuously changed its orientation in relation to the Sun and a portion of time passed in the section of orbit until [illegible] the Sun, the electric circuits of the apparatus were cut-in, for economy of power, only when the Sun was in the field of vision of one of the three light receivers. The cut-in was realized by means of photoresistances lighted up by the Sun [illegible] with photomultipliers on the [illegible] station.

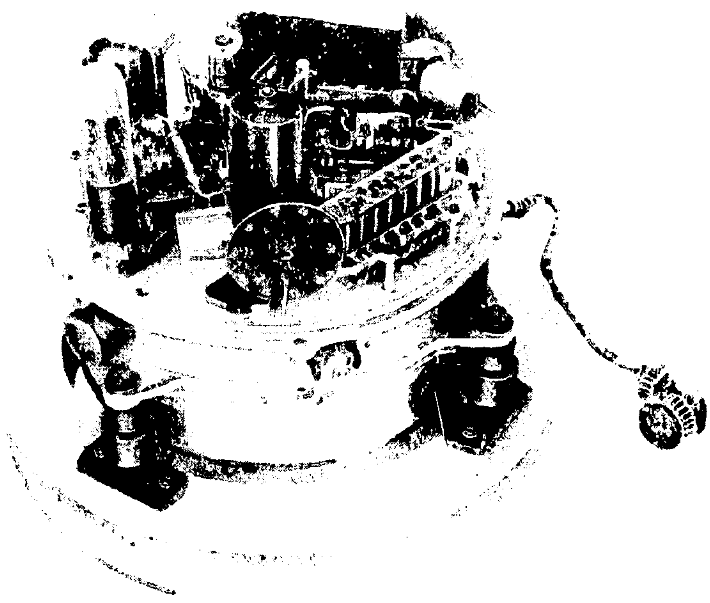

Fig. 4 - Apparatus for investigation of the solar radiation.

Parallel to observations of the solar radiation from satellite, observations of the Sun are being conducted by the whole network of the [illegible] stations, according to the program of the International Geophysical Year. These observations were [illegible], stations, on the study of ionosphere and on reception of the solar radio-emission. Comparison of all these observations will enable to draw the first conclusions regarding the connection of ultraviolet and X-ray radiations of the Sun with processes, taking place in chromosphere and corona of the Sun, and the state of the Earth's ionosphere. These data will serve as basis for subsequent regular observations.

Study of cosmic rays:

Within the outer space atomic nuclei of various elements accelerate and acquire very high energy. The cosmic rays generated in this way make it possible to investigate the cosmic space at great distances from the Earth and even from the Solar System. On the way from the point of generation to Earth the cosmic rays are effected by the medium, through which they pass, As a result of a whole series of processes the composition and intensity of this radiation changes. In particular, the number of particles cosmic rays increase, when there are high intensity flares on the Sun and the conditions are created for acceleration of atomic nuclei upto high energies. Thus there is an additional flux of cosmic rays, generated on the Sun.

The Sun is also a source of corpuscular radiation. The flux of corpuscular radiation has high-intensity magnetic and electric fields, which affect the cosmic rays. By means of cosmic rays it is possible to investigate this flux at great distances from the Earth.

The cosmic rays particles deviate to a great extent, when passing through magnetic field of the Earth. Only particles of very high energy can reach unimpeded at any area of our planet. The lower is the energy of particles, the less are the dimensions of those regions on the Earth attainable to these particles. Particles of low energy reach only the Arctic and Antarctic areas. Thus, the Earth is surrounded by energy barrier. Moreover, the altitude of this barrier, highest in the equator, decreases with the rise of geomagnetic latitude. The equatorial areas could be reached only by cosmic protons with energy greater than 14 billion as electronvolts. Southern areas of the Soviet Union are accessible for particles with energy above 7 billion electronvolts. Finally, Moscow area may be reached by every particle with energy above 1.5 billion electric volts. Measuring of cosmic rays at various latitudes makes it possible to determine as to how many particles and of what energy exactly are present in the composition of cosmic rays. Dependence of the number of cosmic rays particles on latitude, the so called latitudinal effect, determines the distribution of particles according to energy, i.e. the energy spectrum of cosmic rays.

As a result of a series of processes, which take place in the outer space with cosmic rays, the number and composition of particles change. In some cases, as, for instance, with generation of particles on the Sun, there are grounds for expecting, that the increment is only of the number of particles with low energy, whereas the number of high-energy particles remain unchanged. In contrast variation of the Earth's magnetic field and effect on cosmic rays of corpuscular flux, emitted by the Sun, changes not only the number of low-energy particles, but even the number of high-energy particles.

In order to elucidate the nature of variations occurring in cosmic rays, requires fixing not only the fact of increasing or decreasing intensity of cosmic rays, but also determining in what way the number of particles with different energy has changed. Moving at velocity of 8 km/sec, the satellite within a very short period passes from one longitude to another. Thus by means of measuring cosmic rays from satellite it is possible to determine the latitudinal effect of this radiation and thereby distribution of this radiation particles according to energies. Specially significant is the fact that these measurements are carried out many times. Therefore, by means of the satellite it is possible to follow not only the intensity change of cosmic radiation, but also the changes in its composition.

Particles, included in the composition of cosmic rays, are recorded in the satellite by means of Geiger Muler counters. When the electrically charged particle passes through the counter there is a spark, producing impulse on the radio-technical circuit on semiconductor triodes, meant for counting the number of cosmic

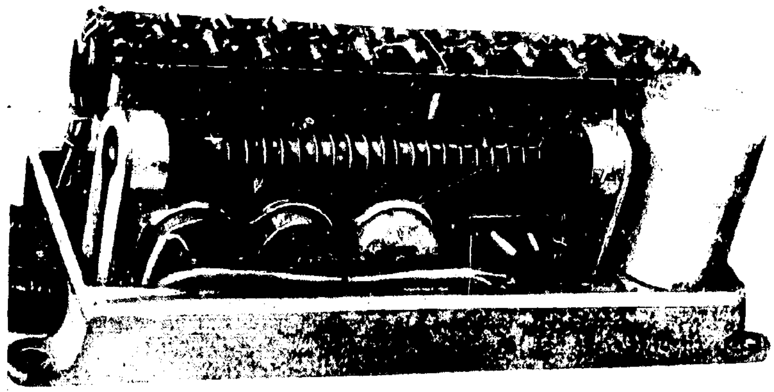

Fig. 5 - Apparatus for the study of cosmic rays.

ray particles and to give a signal when a particular number of particles has been counted. After the transmission by radio signals, the particles of cosmic rays are again recorded and after the same number has been counted a new signal is produced. By dividing the number of recorded particles by the time, during which they were counted, it is possible to obtain the number of particles, passing through the counter per second, or the intensity of the cosmic rays.

Two similar devices are set up in the satellite for the recording of charged particles. The counter axes of both the devices are arranged in the direction perpendicular to each other.

Tentative processing of data on cosmic rays, transmitted from the satellite, has shown, that both the devices were functioning normally. The relation between the number of cosmic ray particles and geomagnetic latitude was clearly defined.

Processing of a great number of measurements of the primary cosmic particles energy spectrum makes it possible to investigate time-variations of this spectrum and to compare it with those processes, which occurred during this time in the outer space surrounding us.

<u>Study of the biological manifestations in conditions of space flight:</u>

In order to study of medico-biological questions the satellite contained a special hermetically-sealed cabin with a dog named "Laika", measuring apparatus for investigating physiological functions of the animal, as well as equipment for air regeneration, feeding of the animal and elimination of its life-activity products. In the construction of equipment the requirements were taken into account of the strictest economy of volume and weight of the instruments at minimum consumption of electric power.

Long-period functioning of the apparatus ensures recording by means of radio-telemetric systems of pulse frequency and respiration of animal, its arterial blood pressure and biopotentials of heart, temperature, air pressure in the cabin, etc.

For air regeneration in the cabin and maintenance of the required gas composition the application was made of highly-active chemical compounds, giving off oxygen, required for the animal's breathing, and absorbing carbon dioxide and excess of water vapors.

The quantity of substance in chemical reactions was controlled automatically. Due to non-convection of air in weightlessness conditions, forced ventilation system was made in the cabin of the animal. Maintenance of temperature in the cabin within certain limits was made of by thermoregulating system. To ensure that the animal gets food and water during the flight an arrangement was made for the feeding of animal.

Prior to being send-off in the satellite the dog Laika was trained. The animal was graudally being accustomed to long confinement in hermetically-sealed cabin of small size in special cloths, to transducers, attached to various sections of body for recording physiological functions, etc. The dog was accustomed to the effect of overloading. Determination on laboratory test-bed was made of the animal's stability to vibration and some other factors. As a result of prolonged training the animal for several weeks calmly submitted to being placed into hermetically-sealed cabin, which provided the possibility of conducting the required scientific investigations.

Study of the biological phenomena during the flight of a live organism in cosmic space became possible due to preliminary extensive investigations on animals during short-period flights in rockets upto 100-200 km, which were being conducted in USSR during a number of years.

In contrast to previous investigations the flight of the animal in the satellite enabled to study the prolonged effect of weightlessness. Still the effect of weightlessness could be studied in aeroplanes during a few seconds and in the vertical launching of the rockets for a few minutes. The flight in the satellite permits to investigate the state of the animal's organism in conditions of weightlessness, continuing for several days.

Experimental data, obtained in the program implementation of medico-biological investigations, are being at present carefully studied in detail. Even now it is possible to say, that the animal under the test have well endured the prolonged effect of accelerations during the placing of satellite into orbit and the subsequent state of weightlessness, continued for several days. The obtained data, show, that condition of animal remained satisfactory throughout the test.

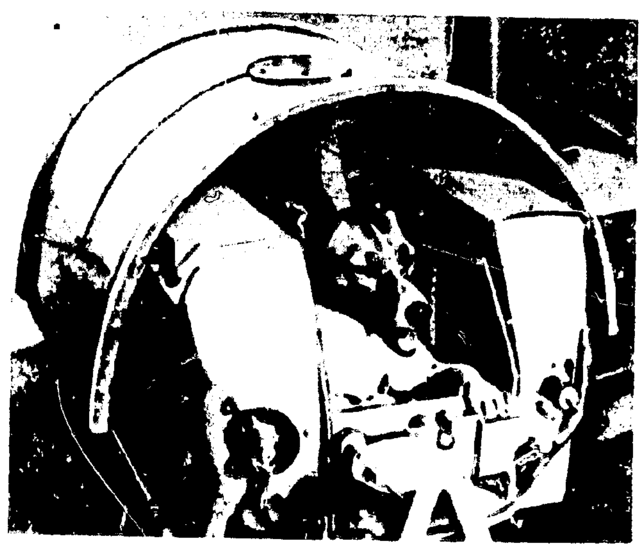

Fig. 6 - The dog Laika in hermetically-sealed cabin prior to it being set in the satellite.

There is no doubt, that the carried out investigations will contribute considerably to a successful mastering of the forthcoming interplanetary flights and will serve as a basis for the development for a safe flight of man in cosmic space.

The launching in the Soviet Union of the first two artificial Earth satellites is a substantial contribution to the study of the upper layers of the atmosphere and extends the boundaries of the Man's comprehension of the Universe surrounding him. At the same time it proves the high scientific and technical level of our country and permits to foresee the time, when the whole of the circumsolar space will be accessible to direct investigation by Man.

"Pravda", 13th November 1957.

SOVIET ARTIFICIAL EARTH SATELLITES

Some results of scientific investigations in the two first Soviet artificial Earth satellites:

On the 4th of October 1957 for the first time in the history of mankind a grandiose scientific experiment has been accomplished - launching of the artificial Earth satellite first in the world. An artificial cosmic body was constructed for the first time by the labor and the creative genius of the Soviet people. On 3rd November 1957 the second Soviet artificial Earth satellite was launched. Both the satellites were equipped by various scientific apparatus.

The successful launching of the first artificial Earth satellites signifies the beginning of the man's penetration into cosmic space. The artificial satellite open out the widest prospects for accomplishment of a whole series of the most important scientific investigations. The study of ionosphere and mechanism of its formation, the effect of the solar radiation and of cosmic rays on Earth atmosphere, study of density, temperature, magnetic and electrostatic fields at high altitudes, etc. are of immense scientific and practical interest.

The resolution of these problems requires setting up of direct tests at altitudes hundreds and thousands of kilometers from the surface of our planet. The possibility for accomplishment of these experiments has appeared with the creation of artificial satellites, which permit to conduct the required scientific determinations at high altitudes above various regions of the Globe for prolonged periods.

Although the significance of artificial satellites for scientific investigations was known long ago, the launching of the satellite until recently was an unsoluble problem. The main difficulty was construction of a rocket, capable of communicating to the satellite cosmic velocity of about 8000 m/sec.

Only after the construction in the Soviet Union of an intercontinental ballistic rocket it was possible to accomplish the launching of an artificial Earth satellite. The excellent constructive qualities of this rocket have made it possible to place into orbit the satellites with heavy weight of the scientific apparatus. The weight of the first Soviet satellite was 83.6 kg, and the scientific and measuring instruments with power packs on the second Soviet satellite had weight of 508.3 kg.

The launching of the artificial Earth satellites with such heavy instruments permits to accomplish a whole set of scientific investigations, simultaneous implementation of which enhances their scientific value. Only in the development of large artificial satellites it will be possible to resolve the problem of designing continuously functioning cosmic laboratories and fulfilment of interplanetary flights.

Scientific problems, which were faced in the launching of the first satellites, have determined the parameters of their orbit. The first Soviet artificial satellite was placed into an orbit with perigee (nearest to Earth point of orbit) 228 km and the apogee (the most distant from the Earth point of orbit) 947 km. For the second satellite these values were 225 km and 1671 km respectively. Revolution period around the Earth at the start of the movement for the first satellite was 96.17 min. and for the second - 103.75 min.

With the movement of satellites along the orbits within the indicated range of altitudes it was possible to carry out a number of tests on the study of upper atmosphere (density determination of the atmosphere, stuay of the propagation of radio-waves, etc.). On the other hand, the density of atmosphere at these altitudes is quite low and does not distort the determination of the primary component of cosmic radiation, spectrum of the short-wave radiation of the Sun, etc.

Scientific problems were presented also by the selection of orbit's dip to the equatorial plane, of about 65°. The advantage of this orbit is that during the flight of the satellite the scientific apparatus, set up in it, may carry out determinations above various latitudes. It should be mentioned, that placing of satellite into orbit with a greater dip to the plane of equator is a more difficult problem, than placing it into orbit close to equatorial.

During its existence - from 4th October 1957 to 4th January 1958 - the first Soviet satellite accomplished about 1400 revolutions around the Earth. The second satellite from 3rd November 1957 to 14th April 1958 completed about 2370 revolutions.

The planned program of scientific investigations has been successfully accomplished by means of the first Soviet artificial satellites. Given below are some tenatative results of these investivations. On the whole the accumulated material is quite extensive and the processing still continues.

Radio-technical and optical observations of the artificial Earth satellites.

Inasmuch as the time-variation analysis of the satellite orbit permits to determine the density of the upper layers of atmosphere, investigation of satellites movement is highly significant. Elements of satellites orbit could be determined on basis of their observation, conducted by radio-technical and optical methods.

Radio-technical methods included direction finding and observations of Doppler's effect in reception of radio-signals from the satellite. The Doppler effect means that with the approach of the object having radio-transmitter to the reception point the frequency of the received signals increase, whereas with the removal it decreases. Frequency variation depends on the rate of removal and approach. In the satellite's flight the rate of approach and removal with respect to the stationary receiving point of the ground is so high, that Doppler's effect could not only be observed on the ordinary radio-receiver, but also used for recording the moment of the satellite's passing at the nearest distance from the observation point, and also for determination of distance to satellite and its velocity.

In radio-observations of signals from the first and second satellites, the frequency of received signals was measured by means of special radio-apparatus and printing chronograph.

In order to enhance the accuracy of measurements, the observations of signals were on frequency of 40 megacycles, which is less affected by ionosphere. The radiation power of transmitters provided for an assured reception of signals within the whole range of direct visibility. Alltogether during 24 hours it was possible to observe 6-7 successive passing of the satellite above the ground stations.

A method was developed for the processing of received signals, which enabled to determine the instant of the satellite passing at the least distance from the observation point with accuracy upto 0.1-0.2 seconds.

The carried out observations show, that Doppler's effect could be successfully used for determination of the parameters of the satellite's orbit. The advantage of this method is the simplicity and reliability of the apparatus. With frequency rise of transmitter, set up on the satellite, and with the use of circuits of the automatic measuring of frequency the errors of method could be considerably reduced.

The simplest optical observations of the satellite consisted in recording the instant of its passage above the observation points.

For a more exact determination of coordinates the application was made of special photocine-theodolites, and for obtaining the photographs of the path of satellite modernized aerophotosurvey cameras were used. Time breaks in photographing were made by means of successive opening and closing of shutter with time recording of these operations by photoelectric method. Thus, the photographs showed a discontinuous trace of the satellite. High accuracy was obtained with the use of these cameras.

In the observations of the artificial earth satellites methods of their photographing by highly-sensitive means were devised. The most promising was found to be the application of electronic image transformers. The new method makes it possible to observe the satellites without the use of any large optical systems, which considerably simplifies the means for observation.

Atmospheric density determination:

Density and temperature of air are the most important atmospheric characteristics. Their determination at high altitude upto the limits of atmosphere is essential for understanding a number of geophysical phenomena. For instance, temperature affects the atmospheric ionization degree, which in turn affects propagation of radio-waves. Motion of meteorites and corpuscular flux in the atmosphere depends on its density. The fastest atoms and molecules at the limits of the atmosphere escape beyond its limits into interplanatary space. The rate of this process depends on the temperature at high altitudes. Finally, in the launching of artificial satellites the time of their existence should be known, and that requires data of the atmospheric density.

On the basis of a number of indirect data (observations of polar lights, meteorites, etc.) some concepts originated regarding the upper atmosphere. These observations resulted in conclusions regarding relatively high density and temperature. Later by correlating rocket investigations, conducted during the last few years, and some theoretical reasoning another point of view has been generally-adopted, according to which the upper atmosphere is colder and less dense, than it was assumed earlier.

Even prior to the launching of the first artificial satellites possibility of determination of atmospheric density and temperature by observing their motion was known. With motion in Earth atmosphere the artificial satellites encounter resistance. The resistance force is proportional to atmospheric density. As a result of the retarding effect of the atmosphere there is a gradual decrement of the altitude of the orbit, along which the satellite is moving. This will continue until the satellite, entering into the dense atmospheric layers, is destroyed.

Density of the atmosphere drops quickly with the height from the Earth's surface. Therefore the force of resistance in various segments of the elliptical orbit is not similar. With quite an elongated orbit the resistance force at the perigee is much higher than at the apogee. Therefore the main declaration occurs in the zone of perigee. This variable declaration results in the fact, that reduction in the altitude of apogee occurs considerably faster, than decrement in the altitude of the orbit's perigee. Evolution of the elongated orbit of the satellite occurs in a way, that its shape gradually approaches circular.

After the launching of the first Soviet satellites optical and radio observations made it possible to follow the evolution of their orbits. Since the effect of atmosphere on satellite in individual sections of the orbit is very insignificant the local retardation at present cannot be measured. From observations of the first Soviet satellites with accuracy, sufficient for an assured density determination of the atmosphere the measurements of all the orbital data were made directly after the launching of the satellite, as well as the variations of their circulation periods from revolution to revolution throughout their existence.

Rate of variation of the revolution period depends to a great extent both on the density of atmosphere in the area of perigee, and on the rate of decrease in density with altitude. The decrement rate of density is denoted by a parameter, known as the "altitude of homogeneous atmosphere", which is directly proportional to the temperature of atmosphere and inversely proportional to its molecular weight.

On the basis of the theoretical analysis of the observation results it was possible to determine with assurance the product of atmospheric density by square root out of "altitude of homogeneous atmosphere" at perigee altitudes of the first satellites (225-228 km). With certain assumptions regarding the value of "homogeneous atmosphere altitude" calculations were also made of the density. As a result it was found, that the obtained value of the density is five-ten times greater than the values, indicated for these altitudes in a number of atmosphere models, plotted on basis of rocket measurement prior to launching of the satellites. It should be mentioned, that density determination from the study of purely mechanical effect of the atmosphere on satellite is quite correct.

The Earth's atmosphere above various regions of its surface is dissimilar. At one and the same altitude density and temperature of atmosphere change in relation to latitude and the time of day. This relation is bound with irregular heating of the upper atmosphere by ultraviolet, X-ray and corpuscular radiation of the Sun.

Due to the fact the Earth's gravitational field is different from the central one, the orbits of the artificial satellites changed their position in space. Thus, for the first Soviet satellites the angular perigean distance from the non meridian varied by about 4 degrees, and the perigean latitude - by 0.35 degree per day.

Since the main effect of the atmosphere occurs in the perigean area of the orbit, the change in position of perigee results in the change of the decelerating force. This permits to estimate the magnitude of latitudinal and diurnal changes in the state of atmosphere.

From the observations of the first satellites estimates were carried out on density determination of the atmosphere, taking into account the variations in the position of the orbital perigee. Estimates have shown, that the product of atmospheric density with the square root of the "altitude of homogeneous atmosphere" increases with transition from the nocturnal side of atmosphere to daylight and reaches its peak value at the noon. Analysis of retardation has also defined decrement in this value with transition from the more northern regions of atmosphere to equatorial. It should be mentioned that there is a good agreement between the values of the density, calculated from the observation results of the first and second satellites and the carrier-rocket of the first satellite.

On the basis of the obtained data it is possible to conclude, that the atmospheric temperature at altitudes of the order of 225 km is higher than previously assumed on the basis of theoretical reasoning. Discovery of high atmospheric temperature poses to geophysicists a problem of the energy sources of its high heating. The known "rigid" ultraviolet and X-ray radiation of the Sun would hardly be sufficient for this. Now it is only possible to form various hypotheses in this connection. For instance, it may be assumed, that the upper atmosphere of polar regions is intensely heated by corpuscular radiation of the Sun. It is possible, that the whole upper atmosphere is additionally heated either by the infrasonic waves, entering from the troposphere, or by electric currents, originating in electro-conducting ionized air as a result of its motion in the magnetic field of the Earth.

Future study of the upper atmosphere by means of rockets and artificial Earth satellites will make it possible to obtain the final answer to all these interesting and important questions.

Results of ionosphere investigations:

Observations of radio-signals from the first artificial Earth satellite made it possible to obtain new data on the external part of ionosphere, i.e., its region above 300-400 km. Ionosphere is the upper part of atmosphere, containing considerable amount of free charged particles (electrons and ions). With transition of radio-waves through ionospheric layers they get reflected, partially or totally absorbed and their propagation paths become curved. Therefore the radio-methods became the most effective means for investigation of the upper layers of atmosphere.

One of the main parameters, characterizing the state of ionosphere, is the electronic concentration, i.e. content of free electrons in one cubic cm. Until now the electronic concentration was measured from the lower layers of ionosphere to altitudes of 300-400 km, where the electronic concentration has the so called principal maximum.

These measurements were conducted mainly by terrestrial ionospheric stations, emitting short pulse radio-signals of various frequency and receiving their reflections from separate layers of ionosphere.

As a result of regular measurements it was fixed, that the principal maximum altitude of ionosphere and its electric concentration vary from day to night, from season to season, with transition from north to south, east to west. The highest electronic concentration, observed in middle latitudes, reached two-three million electrons in cubic cm. Moreover, starting from altitudes 100-110 km upto altitudes 300-400 km electronic concentration increases on an average 10-15 times.

It is most important to know, how the electronic concentration varies above the principal maximum, i.e. in the outer part of ionosphere. This is necessary, in particular, for understanding the interaction of ultraviolet radiation of the Sun with atmosphere, study of the propagation conditions of radio-waves and other processes, occurring in ionosphere. However, study of the external layers of ionosphere from the radio-signals,reflected from them, is impossible, as the radio-waves, emitted from the Earth, are either totally reflected by the lower layers, or pass into the cosmic space. Some information regarding the outer ionosphere could be obtained by studying radio-emissions of Sun and stars, received on the Earth, and also radio-signals received from the Moon.

Propagation observation of various frequency radio-waves, emitted from satellites at various altitudes, are the new means of studying the outer ionsphere.

With reception of radio-signals from the first artificial satellites on frequency 40 megacycles it was possible in some cases to observe in its pure form the "radio-set" and "radio-rise" of the satellite and to fix the corresponding times. In contrast to the optical rise and set of the satellite, which are characerized by the fact, that at this instant the light ray from the satellite to observe is a straight line, whereas in the "radio-rise" or "radio-set" the radio-ray is bent in ionosphere. Because of this the "radio-set" comes on later, than the optical set, and correspondingly the "radio-rise" is in advance of the optical rise. The differense in time of the opitcal rise and the "radio-rise" (or the optical set and the "radio-set") makes it possible to determine the magnitude of the radio-ray curvature. Since the curvature of the radio-ray in ionosphere depends on variation of electronic concentration with altitude, it is possible, by presetting some variation law of electronic concentration, to calculate it theoretically at various altitudes. In this case the effect of the lower layers of ionosphere could be estimated by direct measurements, conducted by the network of terrestrial stations.

Data obtained as a result of observing radio-signals of the first artificial Earth satellites, permit to assume, that electronic concentration in the outer ionosphere (above the principal maximum) drops with altitude 5-6 times slower, than its increment below the principal maximum. Thus, starting from altitude of 100 km to altitude of 300 km electronic concentration increased during the period of observations (in October) about 10 times, and from altitude of 300 km to 500 km it decreased by half.

It should be mentioned, that similar variation of electronic concentration with altitude was also recorded in the launching of the Soviet high-altitude rocket, reported by newspaper "Pravda". In this test at an altitude of 473 km the electronic concentration was about one million electrones per cubic cm.

Investigation of cosmic rays:

For investigation of cosmic radiation the second artificial satellite had two devices, which recorded the number of particles in this radiation. In its rotation around the Earth the satellite was flying at various distances from its surface. Therefore measurements of cosmic rays on satellite made it possible to define the number of particles against the altitude. The processing of obtained material has shown, that from the lowest altitude of the orbit (225 km) upto altitude of 700 km there is an increase in the intensity of cosmic rays by about 40%. This increment is specified primarily by the fact, that with increasing altitude the screening effect of the Earth decreases, and the cosmic rays get the possibility of reaching the device in a greater number from different directions.

The magnetic field of the Earth also builds up an obstacle for the falling of cosmic rays on the Earth. Deviation of cosmic ray particles due to the Earth's magnetic field results in the fact, that to each point of the Earth surface reach in certain direction only the particles with energy above a certain value. Naturally, the further we move away from the Earth, the weaker is the magnetic field and the less its effect on cosmic rays, Estimates show, that the increase in intensity of cosmic rays with altitude, measured during the flight of the satellite, could be explained by the above indicated causes.

In the study of cosmic rays by means of the apparatus, set up in the satellite, the variation of cosmic ray intensity with latitude and longitude could also be obtained. This provides information regarding the magnetic field of the Earth. Measurements of magnetic field on the surface of the Earth give an idea as to the nature of earth's magnetism and make it possible to forecast, what kind of magnetic field should be there at large distances from the Earth. On this basis it is possible to estimate the expected intensity distribution of cosmic rays on the surface of the Earth. In particular, it is possible to indicate the lines of constant intensity of cosmic rays (isocosms). Measurements of cosmic rays, conducted during the flight of the satellite, have shown that lines of constant intensity obtained from experiment and calculated on theoretical basis considerably diverge. This result harmonizes very well with the conclusions of American physicist Simpson, who organised a series of flights of the high-altitude planes in equatorial areas. These flights have shown, that equator, determined by means of cosmic rays, does not coincide with the geomagnetic equator.

Therefore, there is considerable divergence between the characteristics of terrestrial magnetic field, obtained, on one hand, by means of cosmic rays and, on the other, by the measurements of magnetic field on the surface of the Earth. These divergences are explained by the fact, that the trajectories of the cosmic rays motion are determined by magnetic field at very high altitudes, whereas the direct measurements characterize magnetic field in the vicinity of the Earth's surface. Cosmic rays permit to "probe" the terrestrial magnetic field at great distances from the Earth, which provides the possibility of a new approach to the study of the Earth's magnetic field and the system of electric currents in the upper atmosphere.

Observations of cosmic rays on satellite have also enabled to record the intensity variations of this radiation. These variations are, apparently connected with the state of interplanetary matter in the vicinity of the Earth. A case of a sudden increase (by 50%) of the number of particles in cosmic radiation was recorded. Whereas the ground stations have not discovered at this time any appreciable increment in the intensity of cosmic radiation. At present a detailed study is being conducted of this occurrence. It is possible, that it has been caused by the generation on the Sun of low-energy cosmic rays particles (absorbed at high rate by the atmosphere of the Earth) or by the satellite getting into the flux of high-energy electrons (bound with corpuscular radiation of the Sun). These phenomena could not have been recorded until now, since the instruments for a prolonged observation of cosmic rays were located only on the surface of the Earth. The artificial Earth satellites for the first time make it possible to investigate fully the primary cosmic radiation.

Biological investigations:

During the last decade Soviet scientists accomplished a great number of biological experiments in the upper layers of the atmosphere. By means of rockets the test animals were lifted to altitudes of several hundred kilometers. The obtained data made it possible to come closer to defining the nature of biological phenomena, emerging in conditions similar to flights in cosmic space. Direct experimental study of the effect on live organism of such factors, which could not have been reproduced on the Earth, has become practicable now. However, only on the satellite it was found to be possible to accomplish biological experiment in conditions of cosmic flight. This primarily concerns the study of the effect on live organism of a prolonged weightlessness, primary cosmic radiation, some types of solar radiation and other factors.

Data obtained in the implementation of medico-biological investigations program on the second artificial satellite, are of high value. The fact is well known, that on this satellite the dog Laika has performed cosmic flight as the test animal.

The behavior and condition of the test animal during the most difficult, from the biological point of view, stage of the satellite's flight - the launching and transition into orbit - are of great interest. The motion of the satellite in the section of placement into orbit was accelerated moreover, the acceleration exceeded many times the gravity acceleration on the Earth surface. The apparent weight of animal increased in this case according to acceleration.

During the placing into orbit the animal was arranged on the satellite in such a way, that the acceleration would act in a direction from the chest to the back. Overloading in this case pressed the animal to the floor of the cabin. This position of the animal was chosen because it is most favorable for the organism. In the section of placing into orbit simultaneously with acceleration the effect on the animal was of vibration and the noise of the rocket's motor.

The behavior and condition of the animal during the placing into orbit was recorded quite fully. On the basis of the obtained information it is possible to fix, that only up to a certain acceleration value the animal withstood the increment of the appare... body weight and maintained freedom of movement of the head and body. Thereafter it was pressed to the cabin floor and there was no recording of any noticeable movements.

Interpretation of data, obtained from the satellite, has shown, that immediately after the start the systolic frequency increased in comparison to initial approximately three times. Analysis of electrocardiogram recording did not define any morbid signs. A typical picture was marked of increased frequency of heart-beat, the so called sinusal tachycardia. Later, when the acceleration not only continued, but even increased, frequency of heart-beats decreased.

It is easy to imagine, that with the increased apparent weight of the animal the respiratory movements of the chest became difficult, respiration more shallow and frequent. Actually, the recording of telemetric signals has shown, that during the placing of the satellite into orbit the respiration frequency of the animal exceeded the initial 3-4 times.

There are grounds for assumption, that changes, remarked in the st.te of the physiological functions of the animal, are due to the sudden effect on the organism of the quite forcible external irritants : Acceleration, noise and vibrations, which originated at the start and continued in the section of placing into orbit. Analysis and comparison of ob.ained date with results of previous laboratory tests permit to assert, that the flight from the start till the placing into orbit was withstood by the animal quite satisfactorily.

After the satellite was placed into orbit the centrifugal force, acting on the satellite, balanced the force of gravetational attraction, thus setting in the state of weightlessness. In this condition the body of the animal ceased pressing on the cabin floor and due to contraction of the extremities muscles easily pushed-off the floor. To judge from the available recordings, these movements were not continuous and quite even.

Due to the fact, that the animal's chest was not compressed anymore under the effect of increased weight, frequency of respiration decreased. After a very short period of tachycardia the systolic frequency continued subsequently to decrease, approaching the initial. However, the time, during which the number of heart-beats reached the initial level, was about three times longer, than in the laboratory tests, in which the animals were subjected to the action of the same accelerations. as in the placing of the satellite into orbit.

Most probably, this is due to the fact, that after the cessation of the acceleration effect in tests on the ground the animal found itself in normal conditions, whereas on the satellite the acceleration was replaced by the state of complete weightlessness. In this state the sensitive nerval formations of the animal, signalling position of the body in space, did not feel the sufficient effect of external irritants. This caused change in the

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functional state of nervous system controlling circulation and respiration, and determined certain extension in the normalization period of these functions after the cessation of the acceleration effect.

It is also possible, that the pointed out phenomenon was somewhat amplified by the effect of associated factors during the ascent - vibrations and noise, the intensity of which was higher than in laboratory tests.

It should be mentioned, that changes in physiological functions, recorded in the animal at the start of the satellite's motion along the orbit, on the whole coincide well with the results of the previous investigations at high-altitude rockets.

Analysis of electrocardiogram, recorded in the state of weightlessness, defined certain changes in configuration of its elements and duration of individual intervals. These changes were not of the pathological nature and were connected with the higher functional load during the period, preceding the state of weightlessness. The picture of the electrocardiogram reflected transient neuro-reflex shifts in the regulation of cardiac activity. In the next period there was progressive approach of the cardiogram picture characteristic for the initial state of the animal. In spite of the unusual condition of weightlessness, the moving activity of the animal was moderate.

Normalization of the functional indices of circulation and respiration during the weightlessness period, i.e. during the motion of the satellite along the orbit, indicates, apparently, that this factor in itself did not cause any substantial and stable changes in the physiological functions of the animal. Thus, it may be said, that not only the period of placing into orbit of satellite, but even the conditions during the motion of satellite along the orbit, were satisfactorily withstood by the animal.

In providing conditions, required for normal vital activity of the animal in the long flight on the satellite, the most important is the creation of a suitable gas medium,composition and pressure of which would not cause disturbance in the physiological functions of the animal. This problem could only have been resolved by applying hermetically-sealed cabin, in which by means of air regeneration normal atmospheric pressure was maintained with oxygen content within 20-40% and carbon dioxide not over 1%.

The regeneration substances were hightly-active chemical compounds, which by absorbing water vapors and carbon dioxide liberated oxygen. These chemical compounds absorbed also such harmful gases, formed in the process of vital activity of the animal, as, for instance, ammonia. Analysis of obtained data has shown, that oxygen was liberated in sufficient quantity. The fact, that pressure in the cabin did not drop, indicated its reliable hermetization.

It was not possible to form any opinion regarding the effect of cosmic radiation on the animal. No obvious physiological effect of its action was defined directly. Detailed study of this question required careful and prolonged investigation of the test animal after the flight, which is proposed to be carried out in fut..re tests.

The first estimate of the obtained results with all the evidence shows, that conditions of cosmic flight are satisfactorily endured by the animal, Positive in this sense result of experiments enables to continue with even greater persistence and to extend the investigations, the aim of which is to assure safety for the health and life of man in cosmic flight.

Tentative results, given in this article, will be published soon as scientific articles in various journals.

The study is continuing of the extensive scientific material, obtained in the first Soviet artificial satellites both in tests described in this article and other tests, carried out in the first satellites.

The successful launching of artificial Earth satellites has provided the scientists with means for a direct investigation of the upper layers of atmosphere and of cosmic space. The subsequent launchings of satellites during the International Geophysical Year will make it possible to extend the number of important scientific tests, carried out in cosmic space, and to understand more thoroughly a number processes, occurring in the upper atmosphere and in cosmic space.

"Pravda", 27th April, 1958.

TASS COMMUNIQUE OF THE LAUNCHING OF THE THIRD ARTIFICIAL EARTH SATELLITE:

In accordance with the program of the International Geophysical Year the Soviet Union on the 15th of May, 1958 has launched the third artificial Earth satellite.

The object of the launching of the artificial satellite are the scientific investigations in the upper layers of atmosphere and in the cosmic space.

The satellite came out into orbit, dipping to equatorial plane at 65°.

According to initial data, the highest altitude of the orbit above the Earth surface is 1880 km, revolution time around the Earth - 106 min.

The satellite was separated from the carrie-rocket, which moves along a nearby orbit.

At 13 hrs. 41 min. Moscow time on the 15th of May the third satellite passed over the area of Moscow City from south-west to north-east.

The third Soviet artificial Earth satellite has conical shape with diameter of base 1.73m and height 3.57 m without the protruding antennas.

The weight of satellite is 1327 km, including the weight of the instruments for scientific investigations, radio-measuring apparatus and power sources - 968 kg.

The instruments set up on the satellite permit to conduct throughout the orbit the following investigations:

- pressure and composition of atmosphere in the upper layers;
- concentration of positive ions,
- magnitude of electric charges of satellite and intensity of the electrostatic field of the Earth;
- intensity of magnetic field of the Earth;
- intensity of corpuscular radiation of the Sun;
- composition and variation of the primary cosmic radiation, distribution of photons and heavy nuclei in cosmic rays;
- micrometeors,
- temperature within and on the surface of the satellite.

The planned program will enable to study a number of geophysical and physical problems by means of instruments, elevated by the satellite to high altitudes.

For transmission of data to recording stations on the ground the satellite has a multichannel telemetric system with high resolv·.g power. The satellite is equipped with special transmit·ing devices, enabling to measure coordinates of its trajectories.

In order to attract a wide circle of the scientific community of the world to observing the third Soviet artificial Earth satellite it has on board a radio-transmitter, continuously emitting on frequency 20.005megacycles sending telegraphic ... signal with duration 150-300 msec. with high power of emission.

Operation of the scientific and radio-technical instruments, set up in the satellite, is controlled by means of a programming device. Besides, the electro-chemical power source. the satellite has also solar batteries.

Temperature conditions, required for the normal functioning of the in ·uments on bord are provided by the thermo-regulating system, which changes by means of special devices coefficients of luminosity and reflection of the surface.

Observations of the satellite, reception of scientific information and measuring of its trajectory coordinates are conduct·d by specially constructed scientific stations, equipped by a g··at number of radio-technical and optical means. Data of the satellite's coordinates, received f·om the radio-location stations, are automatically converted, tied-in with the single astronomical time and directed along the communication lines into coordination-computing centre.

The measuring information sent from different stations into computing center is automatically input into quick-acting digital computers, which implement determination of the basic orbital parameters of the satellite and calculations of its ephemerides. In observations of the satellite participates a great number of optical observation points, astronomical observatories, radio-clubs and radio-amateurs.

The satellite and the carrier-rocket will be visible in the rays of the setting and rising Sun.

The third Soviet artificial Earth satellite is a new stage in the implementation of extensive scientific investigations in the upper layers of the atmosphere and in the study of cosmic space and is a major contribution of Soviet scientists into International science.

"Pravda", 16th May, 1958.

THE THIRD SOVIET ARTIFICIAL EARTH SATELLITE:

On 15th May 1958 the third Soviet artificial Earth satellite was launched. It was placed into orbit by means of a powerful carrier-rocket. After the carrier-rockets with the satellite reached on the preset trajectory of flight velocity over 8000 m/sec, the satellite was separated from the carrier-rocket by means of a special device and began moving along an elliptical orbit around the Earth. During the separation of satellite from the carrier rocket the protective cone and the protective shields were thrown off the satellite. The carrier-rocket and the protective cone and shields are moving along the orbits, near to that of the satellite.

In its specifications the third Soviet satellite is much more perfect than the first artificial Earth satellites.

The weight of the satellite is 1327 kg, and the total weight of the instruments set up in it with the power source compose jointly 968 kg.

The shape of the satellite is almost a cone, Length of the satellite 3.57 m, diameter of the largest part - 1.73 m without the projecting antennas. A large number of systems is set up on the satellite for conducting most complex scientific tests. The tests are intended mainly for the study of phenomena occurring the upper layers of the atmosphere, and the effect of cosmic factors on the processes in the upper atmosphere.

The satellite is equipped with the most perfect measuring radio-technical instruments, assuring exact measuring of its motion along the orbit, and radio-telemetric apparatus, which continuously records the results of the scientific measurements, their "memorising" throughout the movements of the satellite and their transmission to the Earth during the flight of the satellite above the special stations, located within the USSR territory and conducting reception of the accumulated information. The satellite has a programming device, assuring automatic functioning of its scientific and measuring instruments. This programming device is implemented fully on semiconductors. Moreover, the whole of the measuring, scientific and radio-technical instrumentation is constructed with extensive use of new semiconductor elements. The total number of semiconductor elements on board adds upto several thousands. Power supply of the apparatus is provided by the most perfect electrochemical current sources and semiconductor silicon batteries, converting solar energy into electrical energy.

The heavy weight of the third Soviet satellite proves the high quality of the carrier-rocket, which has placed it into the orbit. Weight of the first Soviet satellite was 83.6 kg. Weight of the scientific apparatus of the second satellite was 508.3 kg. The third satellite has weight of 1327 kg. Total weight of the various apparatus set up in it with the power supply sources adds upto 968 kg.

The continuously increasing weight of the Soviet satellite indicates the future possibilities of our rocket technique. Even now it is possible to launch a rocket into cosmic space, beyond the limits of the Earth's attraction. In order to make it of scientific value and first real step toward the accomplishment of interplanetary flights, this cosmic rocket must be sufficiently well equipped with scientific and measuring instruments and as a result of its launching should provide new information regarding the physical phenomena of the Universe and conditions of cosmic flight.

Scientific apparatus, placed on the third Soviet satellite, will enable to study a wide sphere of geophysical and physical problems. The structure of ionosphere will be studied by observing propagation of radio-waves, emitted from the satellite by radio-transmitter of high power. Besides, there is apparatus for the direct gauging of the concentration of positive ions along the satellite's orbit. Special apparatus permits to measure the intrinsic electric charge of the satellite and electrostatic fields in the atmospheric layers, which are traversed by the satellite. Measurements of the density and pressure are being conducted in the upper layers of the atmosphere. The mass-spectrometer available on the satellite will enable to determine the spectrum of ions, characterizing chemical composition of the atmosphere.

For the study of the Earth's magnetic field at high altitudes there is a self-orienting magnetometer, which measures total intensity of magnetic field.

A series of tests will be devoted to the study of various radiations, falling on Earth and affecting the important processes in the upper layers of the atmosphere. The study is being conducted on the satellite of cosmic rays and corpuscular radiation of the Sun.

Intensity recording of cosmic rays, which is being carried out almost throughout the surface of the Earth, will provide new information about the cosmic radiation and magnetic field of the Earth at high altitudes. The tests are set up on determination of the quantity of heavy nucleus in cosmic radiation. Tests on corpuscular radiation of the Sun will shed new light on the nature of ionosphere, Northern Lights and other phenomena in the atmosphere. A number of units will record impacts of micrometeors.

Highly significant is the new test on recording of photons in the composition of cosmic radiation, which will enable to obtain information on the short-wave electro-magnetic radiation in cosmic space. This is the first test, enabling to study cosmic radiation absorbed by the atmosphere, and the first step in the new stage of astronomy - study of the phenomena in the Universe from short-wave radiation of heavenly bodies. A series of experiments are set up for investigating flight conditions in cosmic space. These include study of heat conditions in the satellite, orientation of the satellite in space and other tests.

The abundance of scientific investigations on the third Soviet satellite characterizes it as an authentic cosmic scientific station. The construction of such a station on advanced technical level and arrangement of such an extensive set of instruments has been made possible by the construction of satellite of very large dimension.

The trajectory of the satellite will pass above every point of the Globe between the Northern and Southern polar circles. This enhances even more the value of scientific tests, being carried out on the satellite. The orbital parameters of the satellite are chosen in a way to assure the carrying out of scientific tests in the range of altitudes with highest interest.

<u>Orbit of the satellite and observation of its motion</u>

The third Soviet artificial Earth satellite was placed into elliptical orbit with an altitude of apogee (the highest point of orbit from the Earth surface) 1880 km. After placing into orbit the satellite was separated from the carrier-rocket. Revolution period around the Earth was initially 105.95 minutes. During 24 hrs it completes about 14 revolutions along the orbit. Thereafter the period of revolution and the altitude at apogee will be gradually decreasing due to the declaration of satellite in the upper layers of the atmosphere. According to tentative estimates, the orbital movement of the third satellite will continue longer, than of the first two Soviet Earth satellites. The orbit dips toward the equator at 65°.

The carrier-rocket immediately after the placing into orbit moved along an orbit, close to that of the satellite, at comparatively short distance. In time the distance between the satellite and the carrier-rocket will be continuously changing due to difference of their braking in the atmosphere. This eventually will result in the shorter existence of the rocket than of the satellite.

Using material, accumulated in the launching of the first two Soviet artificial satellites, it will be possible to forecast with sufficient accuracy the existence period of the third satellite after the processing of the first measurement results of the orbital parameters.

The motion of the third satellite in relation to Earth is similar to that of the first Soviet artificial satellites. At medium latitudes each subsequent turn due to Earth's rotation and precession of the orbit passes further west of the preceding turn by about 1500 km. The precession rate of the orbit is about 4 degrees per day.

Observations of the satellite's movements are being conducted by radio-technical and optical methods. The means and methods of observing the third satellite are considerably improved. The satellite is equipped with several radio-transmitting devices, permitting to determine the satellites coordinates with motion in orbit. These determinations are implemented by a number of specially constructed scientific stations, equipped with a large number of radio-technical means.

Data about the coordinates of satellite, determined by radio-locators, are automatically tied to a single astronomic time. Then by special communication lines these data are transmitted into the general coordination-computing center where data from various stations are automatically fed into quick-acting electronic computors, which implement their joint processing and calculate basic orbital parameters. On the basis of these calculations the forecasting is made of the further movements of the satellite and its ephemerides are issued.

Such a composite measuring complex, including in itself a great number of electronic, radio-technical and other devices, enables to measure the satellite's coordinates and quick determination of its orbit's parameters with accuracy far exceeding that of the first satellites.

Moreover in the observations of satellite participate DOSAAF clubs, radio-direction finding stations and a great number of radio-amateurs. Radio-transmitter set up on the satellite and operating on frequency 20.005 megacycles, continuously transmits radio-signals in the form of telegraph sendings with duration 150-300 msec. Radiation power of transmitter provides for an assured reception of its signals at great distances by means of ordinary amateur receivers. Systematic recording of these signals and specially their tape-recording, easily accomplished by radio-amateurs, will be of high scientific value.

Radio-observations of the satellite, based on Doppler's effect, are also of considerable interest. As shown by the observations of the first Soviet satellites, this method is highly effective and on condition of good correlation of the measuring results to astronomical time will make it possible to obtain accurate data on the satellite's movement.

In organizing optical observations of the third Soviet satellite the experience obtained in the observations of the first satellites has also been taken into account. The network of the optical observation stations has been extended and included a number of foreign observation points. The photographic methods of observation have been considerably improved.

A special interest has application for the photographing of the satellite of the electronic image transformers, which make it possible to obtain a clear photographic image of the satellite at very large distances. Samples of cameras with electronic image transformer have been successfully tested in observations of the second satellite.

<u>The arrangement of the third Soviet satellite:</u>

The third Soviet satellite is a veritable automatic scientific station in space. Its arrangement and construction are considerably more perfect, than the construction of the first satellites. In this construction of the satellite the whole series of specific requirements, connected with various scientific tests to be carried out and disposition of a great amount of scientific and measuring instruments was taken into account. The possible interaction of individual scientific devices required careful working out of the satellite's make up and disposition of the sensitive elements of the scientific apparatus.

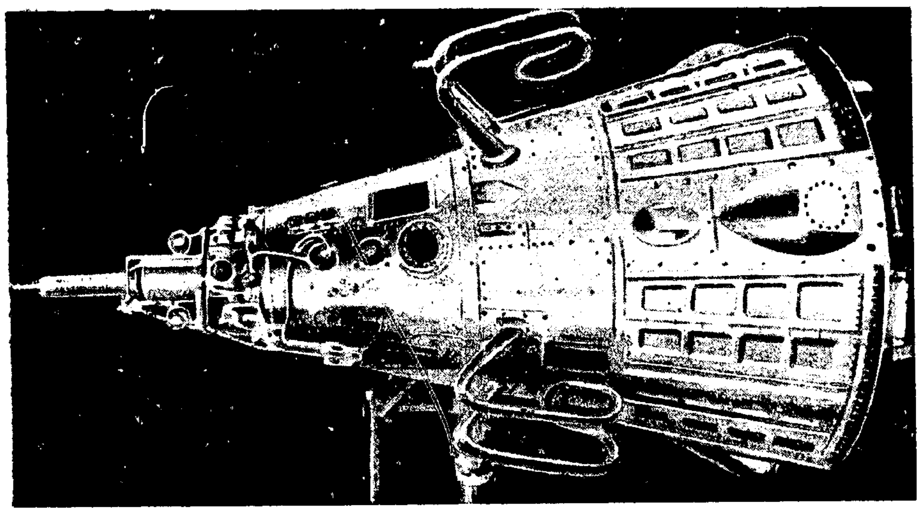

Fig. 7 - General view of the third Soviet artificial Earth satellite.

The hermetical body of the satellite has a conical shape and is made of aluminium alloys. Its surface, just as that of the first satellites, is polished and specially treated for imparting the required coefficients of luminosity and absorption of solar radiation. The removable rear bottom of the body is attached to butt frame by bolts. The air-tightness of the butt is provided by special packing. Prior to launching the satellite is filled with gaseous nitrogen.

Inside the body arranged on the rear instrument frame, made of magnesium alloy, are the radio-telemetric apparatus, radio-instruments for measuring coordinates of satellite, time-programming device, thermoregulation and temperature gauging systems, automatics for switch-on and switch-off of apparatus and chemical sources of power supply. Set up on the rear frame are also devices for measuring intensity and composition of cosmic radiation and for recording impacts of micrometeors. The frame is attached to reinforcement points, on the body sheath.

The main part of devices for scientific investigations together with the sources of power supply are also inside the satellite - on another instrument panel in the forepart. On this panel are the electronic blocks of apparatus for measuringp pressure, ionic composition of atmosphere, concentration of positive ions, size of electric charge and intensity of electrostatic field, intensity of magnetic field and intensity of corpuscular radiation of the Sun. The radio-transmitter is also set up here.

Disposition of the data units of the scientific instruments is determined by their designation. The magnetometer is in the forepart of the satellite and should be as far as possible from the rest of the instruments. The counters of cosmic rays are inside the satellite. Other data units are outside the air-tight body of the satellite. The photo-electric multipliers, serving for recording of corpuscular radiation of the Sun, are attached on the forepart of the body. Inside the cylindrical sleeves, welded into the sheath of the forepart of the satellite, are fitted one magnetic and two ionization gauges, for gauging pressure in the upper layers of atmosphere. Nearby are two electrostatic fluxmeters for measuring electric charge and intensity of electrostatic field, and also the tube of radio-frequency mass-spectrometer determining composition of ions at high altitudes.

On two tubular rods, attached on hinges to body sheath, are spherical reticular ion collectors, which make it possible to measure concentration of positive ions with the satellite's motion along the orbit. In the section of satellite's placing into orbit the rods with collectors are pressed to body surface. Afterward the rods turn on the hirges and get set perpendicular to its lateral surface.

Set up on the rear bottom of the body are four data units for recording impacts of micrometeors.

The solar semiconductor battery is disposed in the form of separate sections on the body's surface. Four small sections are fitted on the front bottom, four sections - on the lateral surface and one section on the rear bottom. This disposition of the solar battery sections assures its normal operation, regardless of the satellite's orientation in relation to the Sun.

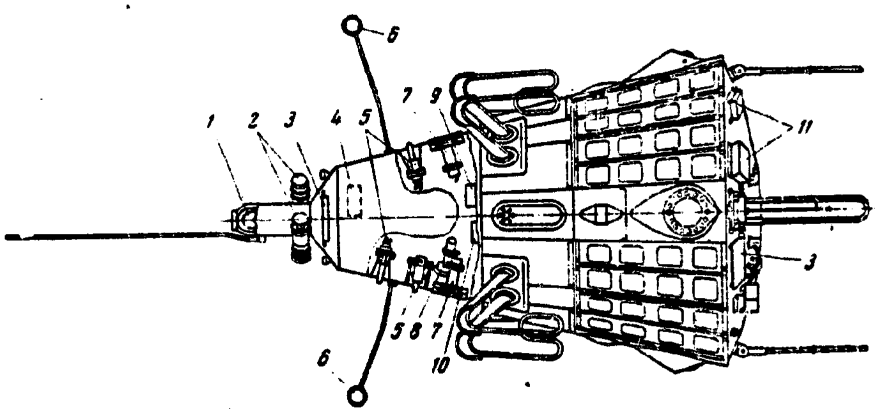

Fig. 8 - Scientific instrumentation of the third Soviet artificial Earth satellite.

1- magnetometer; 2- electrophotomultiplers for recording corpuscular radiation of the Sun; 3- solar batteries; 4- recorder of photons in cosmic rays; 5- magnetic and ionization gauges; 6- ion collectors; 7- electrostatic fluxmeters; 8- mass-spectrometric tube; 9- recorder of heavy nuclei in cosmic rays; 10- device for measuring intensity of the primary cosmic radiation; 11- data units for recording micrometeors.

The front of the satellite is closed by a special protective cone, thrown off after the satellite has been placed into orbit. This cone protects the forepart of the satellite with data units of scientific instrumentation from thermal and aerodynamic effects during the passage of carrier-rocket through dense atmospheric layers. The cone is composed of two half-sheaths, which separate during the throw-off, Besides the protective cone, a considerable part of the external surface of the satellite is covered in the section of placing by four special shields, connected on hinges with the body of carrier-rocket. During the separation of the satellite this shields remains on the carrier-rocket.

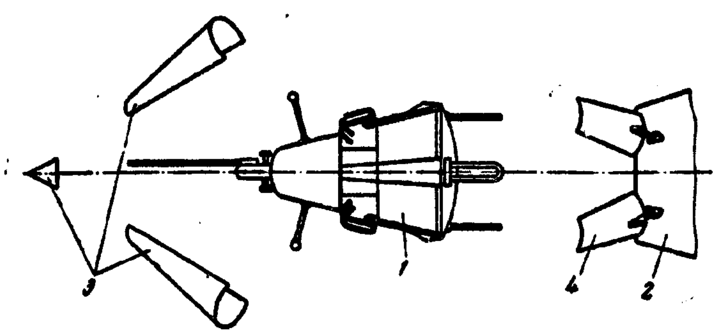

Fig. 9 - Diagram of the satellite's separation from carrier-rocket.

1- satellite; 2- carrier-rocket; 3- separating protective cone; 4- separable from satellite shields.

On the external surface of the satellite is a number of antenna systems, in the form of dowels and tubular constructions of composite shape.

The multichannel radiotelemetric system of the satellite is of high resolving power. It can transmitt to the Earth large amount of scientific information regarding the scientific determinations, conducted on the satellite. The system includes a number of devices, continuously memorising data of scientific measurements during the flight of the satellite along the orbit. During the flight of the satellite above the ground stations the "memorized" information is transmitted from the satellite at high rate.

The system of temperature gauging, available on the satellite, continuously records temperatures at various points of its surface and inside it.

Automatic control of the whole scientific and measuring instrumentation, its intermittent cut-in and cut-off is implemented by electronic time-programming device. This device also issues periodically time-breaks with high accuracy, which is required for the subsequent correlation of the measuring results to astronomical time and geographical coordinates.

The stable temperature conditions on the satellite are provided by the thermoregulating system, which is considerably improved in comparison to those used in the first satellites.

The heat is regulated by changing the forced circulation of nitrogen gas in the satellite, and also by changing coefficient of the intrinsic radiation of its surface. Fitted for this purpose on the lateral surface of the satellite are adjustable shutters, made up of 16 separate sections. They are opened and closed by electric drive, controlled by devices of thermo-regulating system.

Study of ionosphere:

The study of ionosphere figures very prominently in the program of scientific investigations by means of the third soviet Earth satellite.

A number of important characteristics of ionosphere are hardly known. Until now only in single rocket tests direct data were obtained regarding distribution of electronic concentration in altitude in the outer region of ionosphere, lying above 300 km. Even less information is available on concentration of ions. Information regarding chemical composition of ions, highly important from the viewpoint of explaining formation of ionosphere and laws of its time variation, are available only for comparatively low altitudes. Information regarding ionospheric heterogeneities are meagre and controversial.

Detailed study of the structure of ionosphere and investigation of its main characteristics is one of the most important geophysical problems. It should be pointed out, that the resolution of this problem is of primary value for providing reliable radio-communication of the Earth with cosmic rockets, and also for the accurate radio-measurements, connected with the flight of these rockets.

Just as during the flights of the first two artificial Earth satellites, an extensive program is being conducted during the flight of the third Soviet satellite of the propagation obsergation from ground of the radio-waves, emitted from the satellite. Measurements and recording is being carried out of the Doppler's frequency of received radio-waves, field intensity, instants are being fixed of the "radio-rise" and "radio-set" of the satellite, measurements of the rotation of plane of polarization of radio-waves, measurements of the angle of arrival of radio-waves. The results of these observations should provide an extensive material on the state of ionosphere.

Besides the terrestrial measurements direct measurements of ionospheric characteristics are being conducted from the third Soviet satellite.

The specifics of the direct ionospheric measurements by means of the satellite's devices is, that in contrast to methods, based on the study of radio-waves propagation, the measurement results are not dependent on characteristics of the whole thickness of ionosphere between the Earth and the satellite and on processes occurring within it.

Determinations are being made on the satellite of the charged particles concentration in ionosphere and mass spectrum of positive ions. Besides, the intensity measurements of electro-static field close to the surface of the satellite, which affects the results of these tests, the listed measurements compose one single set of tests, supplementing each other.

Measurements of the Concentration of Charged Particles.

There are three main types of free charged particles in ionosphere - positive and negative ions and electrons. The sum of the concentration of negative ions and electrons in equal to concentration of positive ions. The ionosphere is electrically neutral. Therefore, by measuring concentration of positive ions, it is possible to determine the total concentration of free charged particles.

The study of radio-waves, reflected or transmitted through the ionosphere permits to obtain information mainly regarding electron concentration, since the effect of heavy charged particles - ions on the propagation of radio-waves is over thousand times weaker than the effect of lighter electrons. As until recently the radio-waves were the main means for ionosphere investigation, all basic information on content of charged particles in ionosphere referred to electrons. Practically nothing was known regarding distribution of ions.

For measuring the concentration of positive ions along the orbit, two reticular spherical ion traps were set up above the surface of the satellite. Inside of each trap is a spherical collector, which is under the negative potential in respect of the sheath. The electric field induced in this way gathers into collector all the falling into trap positive ions and pushes out the negative particles. Since the velocity of the satellite is many times greater than the average velocity of ions due to heat it may be assumed, that with spherical shape of the traps the ion flux onto the surface of the trap is fully determined by the motion of the satellite and does not depend on the air temperature varying with altitude, and on the orientation of the satellite in relation to its velocity. The exception is the case, when the trap gets into the region of extremely high rarefaction, formed in the wake of the satellite. In the presence of two traps, arranged as above, at least one of them is always outside this region. From the intensity of ion current, flowing into the collector of the trap within the flux, it is possible to determine positive ions concentration in the vicinity of the satellite.

The bond between the measured ion current and the ion concentration is quite simple, if the electric potential, acquired by the satellite during flight in ionosphere, is quite low(for instance, not over 1-2 volts). But if the potential is high, it may substantially affect the intensity of measurable current and should be taken into account. For this purpose the reticular shells of the traps get intermitten short tension impulses relatively to satellite body. This takes off volt-ampere characteristics, which permit to bring-in correction for the effect of the satellite's potential on the flux of ions, getting into the trap. The device makes it possible to measure ion concentration from tens of thousands to five million of ions in a cubic cm.

Measuring the concentration of positive ions will for the first time enable to obtain data on complete concentration of charged particles in ionosphere above various geographical areas of Earth at different latitudes, and also regarding its changes with transition from sunlight region into the shadow region and vice-versa. These data are highly important for understanding interaction of solar radiation with Earth atmosphere.

Comparison of measurements, conducted in the region below the so called principal ionization maximum at altidue 300-350 km, with observation results of the ionospheric stations on the ground, enables to draw a number of conclusions regarding concentation of negative ions at these altitudes and air ionization, caused by the motion of the satellite itself. It may be expected, that concentration measurements of positive ions will provide new data on the structure of the outer region of ionsophere, supplementing data on this region, obtained in the launching of rockets and first artificial Earth satellites. It may also be assumed, that dimensions will be measured of ionospheric heterogeneities.

Investigation of composition of the ionosphere:

Earth atmosphere consists of a mixture of various gases, Its composition on the Earth surface is quite well known. Information on the composition of the upper atmospheric layers is at present rather controversial. One of the most important characteristic of gases, which make up the atmosphere, just as of all the existing chemical elements, are their atomic and molecular weights, generally expressed in arbitrary units, so called atomic mass units. The atomic mass unit is 1/16 weight of oxygen atom. The molecular weight of oxygen composed of two atoms is 32. Atomic weight of nitrogen is 14, molecular weight -28.

By analysing molecular and atomic weights of various compounds and mixtures, it is possible to come to conclusion as to their chemical composition. For determination of atomic and molecular weights of elements and their compounds, making up some mixture, the use is made of mass-spectrometers.

Mass-spectrometer, set up on the third Soviet satellite, is designed for mass spectrum determination of positive ions present in the Earth's ionosphere. With the known mass numbers of ions, it is possible to draw some conclusions regarding chemical composition of ionosphere.

The mass-spectrometer tube - sensitive element of device - communicates with its open input orifice directly with the surrounding space. It contains a number of fine wire grid electrodes, arranged to certain, exactly fixed distances one from another. Beyond the grid is the collector, which is a metal plate collecting ions entering into mass-spectrometric tube after passing all grids.

The electrodes of the tube are fed with various direct and alternate voltages, generated in the electronic block of the mass-spectrometer. These voltages are selected in a way, that only those ions may reach the collector, which have passed through the tube at certain optimum speed. The ions, which pass through the tube at speed higher or lower than the optimum cannot get into the co- -tor. The speed, with which the ions pass through the mass-spectrometer tube is determined, on one hand, by their mass, and on the other - by ion accelerating voltage, applied to some of the tube grid.

The accelerating voltage changes intermit- -ntly from zero to its maximum value. Because of this the optimum speed is communicated in turn to ions with different mass numbers. When ions reach collector, there is emergence of a current impulse in its circuit, which is amplified and transmitted by radio-telemetric system to the Earth. Transmitted simultaneously is the accelerating voltage available at the moment on the grids of the mass-spectrometer tube.

If present in ionosphere are only ions of a single mass, the reception station records only one impulse of ionic current during each variation cycle of accelerating voltage. With a more composite ionosphere the recording is of two or more impulses during each cycle. Mass number of ions, corresponding to each impulse, could be determined by comparing recording of mass spectrum with recording of mass-spectrometer accelerating voltage.

Electrostatic fields investigation:

As a result of some processes taking place both in the interplanetary space and in the atmosphere itself, the Earth with its atmosphere as a whole acquires a certain electric charge.

The electric field generated by this charge should affect the speed and direction of charged particles flying in the interplanetary space. It may affect a number of geophysical phenomena (Northern lights, etc.). Data on electric fields in the upper layers of the atmosphere may help considerably elucidating the causes of the existence of the negative Earth charge and the positive atmosphere charge, which cause difference in potentials between the Earth and ionosphere of some hundreds thousands of volts.

Although in a number of theories explaining the origin of polar lights and corpuscular flux, the presence is assumed of electric fields in the upper layers of atmsophere,direct measuring or their indirect determination was never done. The fact is, that well-conducting layer of ionosphere prevents penetration of electrostatic fields into underlying layers of atmosphere, just as it would have been done by a gigantic metal screen, placed instead of ionosphere.

The same cause prevents measuring by means of devices, located below ionosphere, electrostatic fields existing in the interplanetary space.

Measuring of electrostatic fields by means of satellites is complicated by the fact, that any body, placed in the upper layers of atmosphere, should acquire electric charge, the field of which, if it is not taken into account, will distort the measuring results by adding up with the field being measured.

This charge appears due to inequality in the speed of electrons and positive ions, falling onto the surface of the satellite, and also due to such pehnomena, as photo-effect, i.e. pull out of the electrons from the surface of the satellite by light and other radiations.

The use of satellites for the study of such characteristics of ionosphere, as concentration of ions and their mass spectrum, requires taking into account the disturbances which the satellite introduces in the surrounding medium. Therefore electric charge measuring of satellite inducing redistribution of charged particles in its vicinity, is desireable also for confirmation of results, obtained by these tests. On the other hand, information regarding electric charge combined with data on concentration of ions may make it possible to determine in some cases hardly measurable characteristic of ionosphere, as its temperature.

The apparatus used on the satellite consists of two sensitive electrostatic fluxmeters with common control circuits. It is constructed in the form of two data units, arranged symmetrically on the lateral surface of the satellite, and a block with amplifiers.

The principal part of each data unit is the measuring electrode - a ten-sector plate, connected with the satellite's body through resistance. The plate's surface seems to be a part of the satellite's surface. This plate is periodically shielded by another screening plate, rotated by the electric motor. Since the measuring plate is a part of the satellite's surface, then, when it is open the fractions of the satellite's intrinsic charge and of the charge, induced by the external electrostatic field are present on it. When this plate is shielded the charge runs-off.

During the rotation of the screen the charge of measuring plate periodically discharges along the resistance, building up on it alternative voltage, intensity of which is proportional to the size of the plate's charge. This voltage amplifies, becomes rectified and fed into the input of the radio-telemetric system. The adopted pattern of measurements permits to determine the intensity of electrostatic field, and the use of two symmetrically arranged data units of electrostatic fluxmeter provides the possibility to determine not only the intrinsic charge of the satellite, but also the external electrostatic field.

During operation of the apparatus a special control system enables to check the reliability and accuracy of measurements.

Measuring of the Earth's magnetic field:

The effect of the Earth's magnetic field is defined by observing artificial indicators of the type of magnetic needles , rotating loops, etc. placed within it, as well as by a whole series of geophysical phenomena: deviation in polar regions of charged particles emitted by the Sun, deviation of cosmic rays, polarization of radio-waves. Distribution of magnetic field in size and direction is known in detail only above the continents in the immediate vicinity of the Earth's surface. The data are widely used in the exploration of useful minerals, shipnavigation, aeronavigation, etc.

The nature of terrestrial magnetic field is until now unknown. As a result of prolonged measurements of the Earth's magnetic field in special observatories it has been fixed, that it is time variable. The highest intensity changes of magnetic field are known as magnetic storms.

The analysis of observations has shown, that the main part of the Earth's magnetic field and its secular variations is caused by the sources within the Earth. And vice-versa, the main sources of the short-period variations of the Earth's magnetic field and magnetic disturbances are outside the Earth, in upper layers of the atmosphere.

In the first approximation the magnetic field of the Earth coincides with the field of magnetized sphere or a strong magnet distance between the poles of which is very short, moreover the northern pole of this magnet is in the southern hemisphere of Earth, southern pole - in the northern hemisphere and the axis has an angle of 11.5° with axis of rotation of the Earth. This simple pattern is complicated by the superposition of the fields of continental, regional and local anomalies. An example of the first is the East-Sibirian magnetic anomaly, taking up considerable portion of the continent.

The sources of local magnetic anomalies, for instance of Kurskii anomaly, lie in the topmost layers of earth crust, and the anomalies themselves are quickly decreasing with altitude. There are quite controversial concepts regarding the source localization of continental anomalies.

Mathematical methods permit to estimate the field at high altitudes, if distribution of the field on the surface is known. Definite information regarding the structure of the Earth's magnetic field at high altitudes is provided by the observation of the intensity of cosmic rays at various latitudes. The most mysterious is the fact, that the distribution patterns of the Earth's magnetic field at high altitudes, from magnetometric data on the ground and from cosmic rays observations are not coinciding. Direct intensity measurements at high altitudes by means of magnetometer, set up on the satellite, will make it possible to throw some light on the cause of the observed divergence.

Setting up of magnetometer on the satellite allows to carry out in short time the magnetic survey throughout the Globe. Quite exceptional possibilities are being provided for investigating the variable portion of magnetic field.

According to the present day concepts, magnetic disturbances are caused by high intensity currents, passing in the ionised layers of the atmosphere. At present there is only one known direct experiment, accomplished by means of magnetometer,set up on a rocket, which indicates reality of these current systems existence.

The satellite in its motion along the orbit will intersect many times the ionized layers of the atmosphere. Then the existence of current systems could be marked from the intensity jumps of magnetic field. Separation from the intensities measured by magnetometer of the field of the part, pertaining to the field of the assumed current systems, could be accomplished only by special methods of observation and data processing. Due to the indicated cause the investigation programs of the spatial distribution of the invariable part of the Earth's magnetic field and the variation field generally cannot be combined in one experiment.

The main problem of the experiment on satellite is the spatial distribution investigation of the invariable magnetic field at high altitudes and comparison of the spatial distribution of similar intensity lines of magnetic field and the similar intensity lines of cosmic rays.

Measurement of magnetic field from satellite is bound with considerable difficulties, specified by the fact, that the position of satellite in relation to vector of the Earth's magnetic field continuously changes; magnetometer should have high sensitivity with high range of measurements; data units of magnetometer are affected by magnetic details of other apparatus on board.

Set up on board of satellite is a magnetometer, which enables to overcome these difficulties. It is a device, measuring unit of which is automatically oriented toward the total vector of the Earth's magnetic field at any orientation of the satellite. The measure of magnetic field and its variation is the compensation current, passed along a coil, fitted on the measuring unit, in direction to compensate fully the Earth field in a volume, taken up by the unit.

Two potentiometric data units, set up on the orientation point, permit to determine position of the satellite's body in relation to earth field and rotation speed of the satellite around its own axes.

Study of cosmic rays:

Cosmic radiation investigation permits to obtain information regarding the origination processes within the outer space of particles, possessing very high energy. Moving within the Universe, these particles experience the effect of the matter, through which they are flying. Cosmic radiation is affected by processes, taking place in the Sun and, in particular, by the flux of corpuscles, projected out of its depth. Under the effect of electric and magnetic fields, present in these fluxes, the intensity of the cosmic radiation changes. Changes in the state of interplanetary space, surrounding the Earth, also results in changing the nature of motion of the cosmic ray particles, originated in the most distant parts of the Universe and moving toward the Earth. Sometimes there are high power blasts taking place on the Sun, resulting in origination of cosmic rays. These processes are still little known, and their investigation is of great interest.

As a result of cosmic rays deflection in the Earth's magnetic field, the equatorial areas of the Earth could be reached only by particles with energy of over 14 billion electron volts. High latitudes may be reached by particles of very low energy. By shifting along its orbit the satellite makes it possible to record separately the cosmic radiations of different energy.

The counter of cosmic rays, set up on the satellite, will enable to obtain new data regarding intensity variations and energy spectrum of cosmic radiation.

The search in the compositions of cosmic rays for the finest light particles - photons is of special significance.

Photons, having considerable energy, the so called gamma-rays, could point out better than any other component of cosmic radiation, where this radiation originates. The propagation of gamma-rays in the outer space should be practically rectilinear. Therefore by discovering in what direction gamma-rays are moving, it is possible to point out the location of their source. In contrast the particles of cosmic rays, having electric charge, highly deviate in magnetic fields, existing in the cosmic space, and lose the initial direction of their motion.

The discovery of gamma-rays in the composition of cosmic radiation involves great difficulties, moreover, as at present it is impossible to forecast their intensity. Satellite existing for a long time outside the Earth atmosphere provides exceptional possibilities for discovery of this new component of cosmic rays.

The device, set up on the satellite, makes it possible for the first time to accomplish an experimental attempt to define gamma-rays in the primary composition of cosmic radiation. If this attempt will be successful, it will be possible to speak of the new method for investigation of the Universe.

It is a known fact, that about 70% of the cosmic rays primary flux, entering into the upper layers of the atmosphere, is composed of protons - nuclei of the lightest element - hydrogen. Besides protons the primary flux of cosmic rays contains nuclei of other elements also. Helium nuclei (alpha-particles) are present in quantity less than 20%, and the nuclei of heavier elements compose altogether about 1%. Although the number of these particles is not high, but the energy contributes by them is about 16% of the energy of the whole cosmic rays flux, It is important to know more fully composition of the primary flux. Information on composition of cosmic rays, in particular, is of considerable value for the answer to the question, where and how such high energy particles are produced.

Quite a lot of information on the composition of primary cosmic rays was obtained as a result of lifting instrument on sounding balloons. However, it is impossible to obtain a whole series of data on the primary composition by conducting measurement in the stratosphere, since even a negligible layer of substance, which is always present above the device, changes composition of cosmic rays. Upto now it is unknown, whether the cosmic rays contain by appreciable number of heavier elements nuclei, than those of iron.

Setting up on artificial satellite of device for recording heavy elements nuclei makes it possible to get an answer to this important question for science. The main detail of this device is the so called Cherenkov's counter. The action of the counter is based on the use of Cherenkov radiation, originating in the case, if the charged particle moves in substance at speed, exceeding the speed of light in this medium.

An important property of Cherenkov radiation is that the intensity of light flare, generated in the substance with the passage of particles, is proportional to the square of charge of the particle. Moreover the particles, moving at speed less than the speed of light in the substance, do not radiate light. This property of the Cherenkov radiation permits to use it for the recording of charged particles, their charge determination and separation from the whole flux of particles only those with sufficiently high speed.

The Cherenkov counter consists of plexiglass detector-cylinder, attached to the end of which is a photoelectric multiplier. While passing through detector the particle of cosmic rays with velocity close to 300 thous. km/sec, generates in it the Cherenkov radiation. The velocity of light in the plexiglass is about 200 thous. km/sec, and hence the conditions are there for the generation of Cherenkov radiation.

The light, radiated in detector, is absorbed by the photomultiplier, which converts it into electric signal and amplifies it upto a degree, required for the operation of device. The device sorts out all signals into two groups, corresponding to the flight through detector of particles with charge over 30 and particles with charge over 17. With each flight of particle through Cherenkov counter the signal is given regarding which group of nucleus has passed through the device.

Investigation of the solar corpuscular radiation:

The solar electromagnetic radiation encompasses infrared, visible, ultraviolet and X-ray regions of the spectrum. Sometimes ejected from the Sun into interplanetary space is ionized gas, consisting of electrons and ions. With removal from the Sun a portion of ions becomes neutralized, i.e. converted into ordinary atoms. The particles erupted from the Sun are usually denoted as corpuscular radiation of the Sun. Jointly with the corpuscular flux propagate the related magnetic fields. From various estimates the corpuscles in the vicnity of the Earth have velocity in the order of several thousands kilometers per second.

During the passage of corpuscular flux near the Earth there is origination of magnetic disturbances, the most intensive of which are called the magnetic storms, Simulteneously there is emergence of polar lights. With penetration of corpuscles into atmosphere its ionization increases both in the upper and lower layers. Increased ionization in the lower denser layers results in disruption of radio-communication, since there is intensive absorption of radio-waves. Corpuscular intrusions are accompanied by disturbance of thermal conditions in the upper atmosphere.

The majority of the solar corpuscles is charged particles. These corpuscles penetrate into atmosphere most frequently in the vicinity of geomagnetic poles of the Earth in polar regions. Due to the curvature of the trajectories in magnetic fields the charged particles penetrate also into the night side of the Earth, close to polar zones. Corpuscular intrusions take place also in moderate latitudes, but here their intensity is lower. The neutral corpuscles could penetrate unhindered into any place of the Globe.

Information regarding the corpuscular radiation of the Sun is too meagre, and its nature and properties are little known. Until quite recently the main information on corpuscular radiation of the Sun was derived from the observations of polar lights.

The artificial Earth satellites are an effective means for investigating the corpuscular radiation of the Sun. The present time is specially favorable for this investigation, as the corpuscular radiation is intensified due to the rise in solar activityl

Set up on the satellite are two indicators of corpuscles. These indicators are flourescent screens, covered by thin aluminium foil of various thickness. In this way a rough sorting of corpuscles according to their penetration capacity is obtained.

Placed in front of the fluorescent screens are diaphragms, which limit the solid angle of the capture of corpuscles. Under the effect of the corpuscles the fluorescent screens glow, in a similar way as the television screen glows when irradiated by electronic ray. The radiation of the screen is absorbed by photoelectric multiplier. Its signal is "memorised" by a special device and then transmitted to the Earth by radiotelemetric system.

By means of this apparatus it will be possible to obtain valuable data on geographical, altitude and diurnal distribution of corpuscular flux. For direction investigation of corpuscles arrival the use is made of the satellites rotation. The Earth's magnetic field has the capacity to reflect the charged corpuscles and force them to follow spiral paths along the magnetic lines of force. The neutral corpuscles may shift along the rectilinear trajectories. These observations will provide additional material for judging the nature of corpuscles.

Besides the recording of corpuscular radiation of the Sun the apparatus permits to obtain additionally the data on its X-ray radiation, which will be recorded by corpuscle indicators. It will be possible to distinguish this radiation from the corpuscular one by the direction of its arrival and by the absence of reflection from the Earth's surface. Moreover, it could be marked by the time of appearance, as the corpuscular radiation propagates slower than the electromagnetic radiations.

Atmospheric pressure and density measurements:

One of the most important geophysical investigations of the upper atmosphere is the study of pressure and density variation with altitude. With these two parameters known, the atmospheric temperature may also be determined at high altitudes.

Until recently this study was limited to comparatively low altitudes, and it is only the high altitude rockets which have made it possible to measure the pressure and density in the upper atmospheric layers. At an altitude of 100 km the pressure and density are approximately ten million times lower than on Earth. Single rocket measurements are available for altitude above 100 km, but these are hardly in agreement with indirect data. An essential shortcoming of the rocket measurements is their short duration and the fact, that they are carried out at particular points of the Earth's surface.

It is extremely important for geophysics to have data on the density and pressure of the upper atmospheric layers at every latitude and longitude, by carrying out measurements for a prolonged time.

The use of the satellites provides the possibility for confirming and extending the available concepts regarding the structure of the atmosphere. The prolonged presence of device at high altitude and comparison of measurement results from turn to turn will enable to conduct a detailed analysis of experimental data and to exclude the possible errors of the test.

With sufficient accuracy of experiment it will also be possible to evaluate diurnal and latitudinal variations of density and pressure at high altitudes, where the satellite is flying.

Pressure gauges, set up on the outside of the satellite, is connected to the apparatus from inside. Pressure gauging at the satellite in the range of 10-5 - 10-7 mm of Hg is conducted by magnetic pressure gauge, and in the range 10^{-6} - 10^{-9} mm Hg - by ionization gauge.

Micrometeor investigation:

It is a known fact, that in the space between the planets there is a motion of fine solid particles - micrometeors. When they enter into Earth atmosphere they are burnt. And the noticeable glow, discoverable visually or through telescope, is caused only by comparatively large particles. The finest and, as may be assumed, the most numerous particles of a few microns in cross-section, cause such an insignificant glow, that it can neither be discovered by optical means nor by any means of observations from the ground.

Radiolocation observations have fixed, that micrometeors, invading Earth atmosphere at very high velocities of upto 70 km/sec, cause ionization of air molecules during their motion in the atmosphere. Following the flying particles is a wake of charged particles - electrons and ions, which is discovered by radio-locator, Nevertheless even this method does not permit to study the finest of the micrometeors. At present these particles could be studied only by means of apparatus, lifted on rockets and, in particular, on artificial Earth satellites.

Study of the interplanetary matter is of essential value to astronomy, geophysics and astronautics, and also for resolving problems of evolution and origin of planetary systems, since it permits to elucidate a number of problems, essential for the present-day cosmogonic theories.

DISCOVERIES, WHICH EXTEND KNOWLEDGE OF THE UNIVERSE:

Some results of the scientific investigations on the third Soviet artificial Earth satellite.

In accordance with the program of the International Geophysical Year a large amount of work was carried out in the Soviet Union on investigation of the upper atmosphere and cosmic space by means of artificial Earth satellites.

At the Universal Assembly of the Special Committee of the International Geophysical Year held in Moscow, great attention was paid to the papers of Soviet scientists, dealing with the study of the motion of Earth satellites, parameter gauging of atmosphere - pressure, density and temperature in its upper layers, investigation of cosmic rays, magnetic field of Earth, corpuscular radiation of the Sun, micrometeors, study of the performance of solar silicon batteries, vital activity of live organisms in conditions of cosmic flight and a number of other problems.

Discussion at the Assembly of operations, conducted on the artificial Earth satellites, has shown, that Soviet science has progressed into the front line of World science in the sphere of investigations on rockets and satellites. Considerable weight of the Soviet Earth satellites enabled to arrange on their board numerous composite scientific apparatus. The high constructive specifications of the Soviet artificial satellites assured normal working conditions of the apparatus on board. All devices operated at preset temperature of 15-22°C. The whole set of operations was fully automatized. All devices were cut-in and cut-off by means of a special programming device. Analysis of radiotelemetric recording shows, that the whole scientific apparatus on the third artificial satellite operated normally and the planned program of scientific measurements has been fully implemented.

Study of the motion of artificial Earth satellites has made it possible also to obtain very valuable and interesting data regarding air density at the altitude of the satellites flight and a whole series of data on special features of their motion.

Dynamic effects in the motion of artificial Earth satellites:

The orbit of the artificial satellite is determined by a number of parameters: distance from the centre of the Earth to the most distant point of the orbit (apogee), distance to the point nearest to Earth centre (perigee), inclination or orbit i - angle between the orbit plane and the plane of the Earth's equator, longitude of ascending node , which determines the angular distance from the invariably directed into point of vernal equinox axis CX to the intersection line of orbital and equatorial planes, and also by the angular distance of perigee from the orbital angle of ascent (Fig. 10).

If the Earth was a uniform sphere and there was no atmospheric effect on the motion of satellite, the orbit would have remained invariable in space, i.e. the angle i, ,W and distances to perigee and apogee of the orbit would have remained invariable, moreover the Earth, in its diurnal rotation would have been spinning in such an orbit as in a ring.

Mainly two types of disturbances affect variation of the satellite's orbit. It is the difference of the Earth's gravitational field (the field of Earth attraction) from the field due to a uniform sphere and the atmospheric effect. The first of these factors results in position change of the orbit in space. With this in the first approximation the inclination of orbit remains invariable, but there is change in angles and . Thus, for instance, for the first, second and third Soviet satellites the angle varied at the start of their motion by 3.157, 2.663 and 2.528 degrees per day in direction east to west. At the same time there was a gradual shifting of perigee southward, i.e. change in the angle , which was 0.432 and 0.407 degrees for the first and second satellites and 0.326 degrees for the third. Since the variation rate of these parameters depends on the nature of the Earth's gravitational field, it seems possible to confirm the characteristics of the gravitational field. At present the knowledge of the Earth's gravitational field is in such a state, that confirmation of its parameters from the observed evolution of the satellites orbit requires very careful observations for a long time.

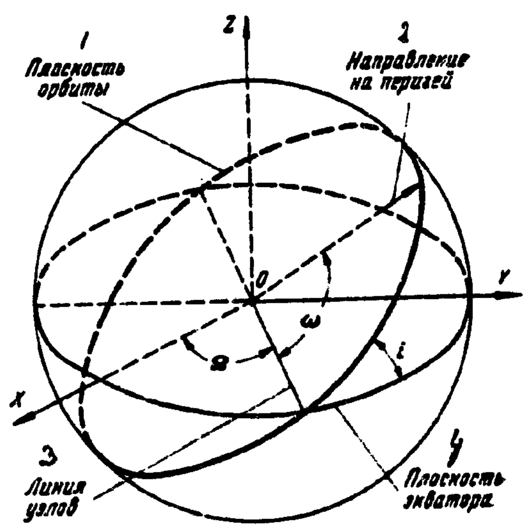

Fig. 10 - 1. orbit plane; 2. direction to perigee ; 3. line of nodes; 4. equator plane.

With the motion in Earth's atmosphere the artificial satellite encounter air resistance. This resistance also causes change of the orbit. The mean radius of the satellite's orbit becomes smaller, moreover for elliptical orbit its change is mainly due to reduced altitude of apogee. Decrease in the altitude of perigee is considerably slower. In time the orbit of the satellite gradually approaches circular.

Thus, for instance, for the second satellite altitude of perigee above the Earth's surface during 1500 revolutions changed approximately by 25 km, and the altitude of apogee - by more than 500 km.

The shorter path, which the satellite has to traverse during one revolution, and some increment in the velocity of its motion in approaching the Earth's surface results in that the time of revolution period gradually decreases. The variation rate of period depends on the magnitude of resistance force, and the higher is the density of air at altitudes of the satellite's orbit, the greater will be the force of resistance. The direct bond between variation of the satellite's orbit and, in particular, change in period of its revolution and density of atmosphere permits to determine from the analysis of period changes the density of atmosphere.

Air density at altitudes above 200 km is billions of times less, than on the Earth's surface. Therefore the resistance force there is very low. Change in period of one revolution is measured by the tenth fractions of a second. Thus, for instance, change in period during one day at the start of the motion for the first satellite was 1.8 sec., for the second satellite - 3.08 sec., for the third - 0.75 sec. In order to reduce the possible error in determining change in the revolution period, methods of mathematic processing of a very large number of measurements are applied. High number of observations permit to define incidental erroneous measurements and to determine with high accuracy the evolution of the satellite's orbit. Thus, from the first satellite 60,000 of radiotechnical and 400 optical measurements were processed, from the second satellite 12,800 radiotechnical and 2000 optical. And tens of thousands of measurements were already processed from the third satellite.

Density determination of atmosphere from the observable retardation of satellites requires knowledge of their aerodynamic factors. The value of aerodynamic resistance factor depends on the shape of the satellite, nature of the air molecules reflection, and also on the orientation of satellite in relation to oncoming flow. For estimation of aerodynamic factors results of the rarefied gases dynamics were used. The motion of the satellite depending upon its center of gravity was studied.

If there was no atmospheric effect and other disturbing factors, the motion of satellite with a symmetry axis would have been a regular precession, i.e. the satellite would have been revolving uniformly around its longitudinal axis, which in turn would have been rotating around another axis (precession axis), stationary in space.

Under the effect of the atmosphere and gravitational field of the Earth the motion of satellite near the gravity center becomes more complex; the longitudinal axis of the satellite revolves near the precession axis, the position of which in space gradually varies with time in accordance with certain laws, varying for different satellites. Moreover, under the effect of electromagnetic forces the rotation speed of the satellite decreases. Analysis of test results on investigation of solar radiation enabled to draw some conclusions regarding the motion close to the gravity center of the second satellite at the start of its existence. The second satellite performed precession close to the axis, which had with the longitudinal axis of satellite an angle of 86°. The precession period was about 206 sec. A number of conclusions regarding the rotation of satellites was possible to draw from the observed variation period of their luminosity.

Magnetometer set up on the third satellite fixes position of some of the satellite axes in relation to magnetic field of the Earth. Processing of magnetometer's reading permits to calculate quite accurately orientation of the satellite in space and the characteristics of its rotation.

Knowledge of orientation is required for the correct analysis of measuring results by devices, set up on the third satellite. Moreover, calculation of the satellite's orientation permits to check a number of theoretical deductions, made previously of its motion close to the gravity center. The obtained tentative results show, that the motion regime of the third satellite was also close to that of regular precession, moreover the longitudinal axis of the satellite is at an angle of 84° to precession axis. The precession period is approximately 140 seconds, and the period of satellite's rotation close to its longitudinal axis is about 18 minutes. Change in the direction of precession axis in space was also defined.

The atmosphere at a given altitude from the Earth's surface could be characterized by two parameters - its density and altitude of homogeneous atmosphere. The altitude of the homogeneous atmosphere is directly proportional to air temperature and inversely proportional to its molecular weight. Thus, close to the Earth's surface, where the average mass of molecules is $4.8 \cdot 10^{-23}$ grams, and temperature is 273 degrees on absolute scale, altitude of the homogeneous atmosphere is 7.9 km. The reduction rate of density with altitude depends on this parameter. The lower is the altitude of the homogeneous atmosphere, i.e. the lower is the air temperature and the higher is its molecular weight, the higher is the rate of atmospheric density reduction with altitude. Satellite in motion along the orbit passes at various altitudes from the Earth's surface and the resistance force varies.

Theoretical analysis shows, that the variation rate of the satellite's revolution period is determined mainly by the product of atmospheric density by the square root from altitude of homogeneous atmosphere at the altitude of the point of orbit nearest to Earth.

As a result of the analysis of satellites retardation average density was determined at the altitude of the orbit's perigee (226-228 km), which was found to be equivalent to three ten-millionth grams in one cubic metre. This value exceeds about 5-10 times those, which previously adopted in a number of atmosphere models, composed on the basis of theoretical processing of the rocket observations.

During the life-time of the satellite the point of orbit nearest to Earth shifts in space: has its approach to Earth under the effect of the atmospheric resistance to the motion of satellite and variation of its latitude and longitude. Position comparison of the nearest to Earth point of orbit and the observed at the same time retardation of the satellite permits to determine the characteristics of the atmosphere above the points of the Earth's surface different in sun-light and latitudes. As a result of the analysis of retardation of the first two Soviet satellites it was defined, that with transition of orbit's perigee from the night-side to daylight the braking varies in a way, that the determinable product of atmospheric density by the square root out of the altitude of homogeneous atmosphere increases by 20-30%.

Tentative analysis of the third satellite's retardation has made it possible to define the diurnal variations even more clearly; with transition of perigee from mid-day atmosphere to the night atmosphere there is decrease in the product of atmospheric density by an amount more than one and a half times of the square root of the homogeneous atmosphere altitude retardation analysis of the second satellite also defined reduction in the atmospheric density with transition from northern latitudes to southern. Further study of the third satellite's retardation will make it possible to confirm quantitative conformities of diurnal and latitudinal variations of the atmospheric parameters. Using data on atmosphere, obtained by means of the artificial satellites, it will be possible to plot a model of atmospheric density distribution within a wide range of altitudes.

Result of atmospheric density gauging:

Pressure gauging on the third Soviet artificial Earth satellite in sections of orbit with lowest altitudes was conducted by special magnetic electro-discharging pressure gauges within 10^{-5} - 10^{-7} mm Hg, and in sections of orbit with high altitudes in the interval 10^{-5} - 10^{-9} mm Hg.

The pressure gauges, set up on the third satellite, were arranged on the body and had contact with the surrounding space.

Some time after the exit of the satellite into orbit the gauges were opened by a special breaking mechanism, and their hollows filled with molecules of surrounding matter. In the thermo-ionization gauge molecules fallen into its cavity collide with electrons emitted by cathode (incandescent wolframium filament) of the gauge. As a result of collision the molecules become ionized and the forming positive ions are collected on the electrode grid (collector), which is negatively charged. The number of positive ions is proportional to the number of electrons, flying per unit of time from cathode to anode. The measure of the gas pressure will be the intensity of ionic current taken off the collector.

In the magnetic electro-discharging pressure gauge the free electrons, fallen jointly with gas molecules into its cavity, are twisted around the magnetic lines of force of the constant magnetic field, which is induced between the anode and cathode from the constant magnet. Colliding with molecules the electrons induce their ionization, as a result of which there is discharge current in the circuit of the pressure gauge proportional to the amount of formed ions.

The use of ordinary gauges for measuring pressure of the indicated range in ionized medium is impossible, as the currents, formed in the guage by the ions present in free atmosphere and electrons, are comparable with currents in gauges, which are the measure for the atmospheric pressure.

Therefore in ionization gauges, applied for pressure gauging in ionized matter, these currents are divided by means of special shields and traps and the measuring is only of currents, which are the measure for pressure. The current of the gauge is amplified by direct current amplifier and fed into telemetric input. Throughout the satellite's flight there is continuous recording of the ionic current in the gauge, intermittent calibration of amplifiers, recording of the emission currents of the gauge, temperature measuring of the gauge's wall.

Atmospheric pressure and density gauging at high altitude is an extremely complex problem. Prior to the accomplishment of the experiment the possibility of pressure gauging on satellites by means of pressure gauges was even disputed.

Special attention was paid to determination of the satellite's

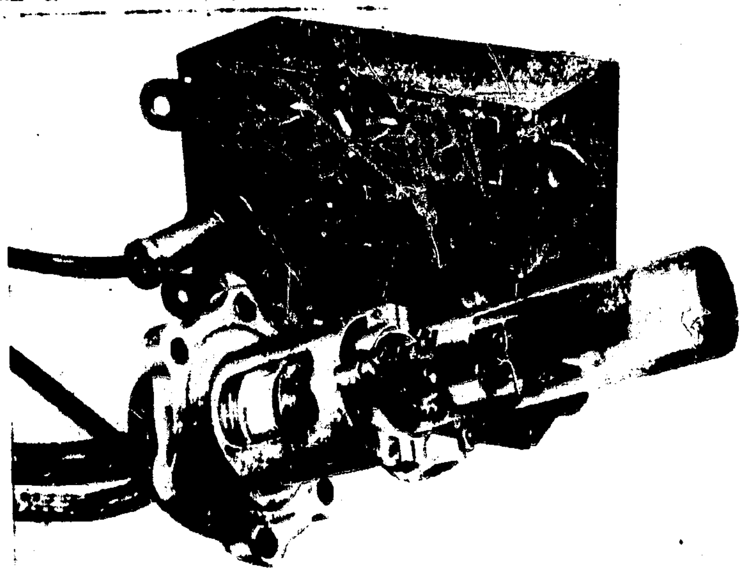

Fig. 11 -Ionization chamber and direct current amplifier.

gas generation. The process of gassing is specified by the fact, that gases may be present on the surface of the satellite captured from the lower layers of the atmosphere. This process could be quite active due to the low density of the surrounding medium. Moreover, if the satellite itself is not sufficiently air-tight, gassing is possible from inside the satellite. All this may cause appreciable distortions in the reading of the pressure gauge. In order to eliminate the effect of gassing on the reading of the pressure gauge an extensive work was conducted on time determination of various constructive material degasing and the build-up of high-quality air-tightness of the satellite. On the basis of these investigations and calculations the selection was made of material for the construction of the satellite and requirements determined of its air-tightness.

Atmospheric pressure and density are complex functions of the pressure gauge reading, velocity of satellite, its orientation in space, composition and temperature of gas in atmosphere and in the pressure gauge.

In order to provide reliability and control of the gauges operation the third Soviet satellite had two thermo-ionization and one magnetic gauge . In accordance with the program, the measurements were conducted for a week. During this time pressure and density of the atmosphere were measured at various geopraphical latitudes, longitudes and altitudes.

Analysis of the processed material shows, that density at altitude 266 km is ten billion times lower than on the Earth's surface, and with the increment of altitude by 100 km more it decreases again 10-12 times. These results are consistent with density determination from the retardation of satellites.

Determination of the Ionic composition of ionosphere:

Set up on the third Soviet artificial Earth satellite was a device for the ionic composition investigation of ionosphere.- radio-frequency mass-spectrometer, designed for mass spectrum determination of positive ions, present in the Earth's ionosphere.

The most important characteristic of gases in the composition of atmosphere (as of all the existing chemical elements generally), is their atomic and molecular weight, which are usually expressed in arbitrary units, the so called atomic mass units. The atomic mass unit is 1/16 of the oxygen atom weight.

By analysing molecular and atomic weight of various compounds and mixtures it is possible to deduce their chemical composition.

The principle used in the radiofrequency mass-spectrometer is the division of ions by velocities. The main detail of device is the spectrometric tube, which is electro-vaccum lamp of special construction with a high number of plane-parallel grids. Beyond the grids is a collector - metal plate, which collects ions entering into mass-spectrometric tube after they passed through all the grids.

The tube's electrodes are fed with various direct and alternate voltages. They are selected in a way, that the collector may be reached only by those ions, which passed through the tube at certain optimum velocity.

When the ions reach the collector, an impulse is generated in its circuit. Mass number of ions, corresponding to each impulse, can be determined by comparing the recording of the mass spectrum with recordings of mass-spectrometer accelerating voltage. New data has been obtained on ionic composition of ionosphere in a wide range of altitudes from 230 to 950 km.

The experiment conducted has shown, that predominant in this region of ionosphere are the ions of elementary oxygen. The ions were also recorded of elementary nitrogen, but in a considerably lower quantity (3-7% of the oxygen ions). No ions were discovered of molecular oxygen and nitrogen. Besides those indicated, mass-spectrometer has recorded at the start of the flight the ions water vapor.. Careful analysis of obtained data indicates, that this water owes its presence to the satellite itself, which has brought it on its surface into the upper layers of atmosphere. However the fact of the evaporating water vapors in the upper atmosphere remains mysterious.

Very interesting from the biological point of view are the results of discovering appreciable quantity of ions at altitudes of about 1000 km, where according to the old concepts the Earth's atmosphere changes into interplanetary gas.

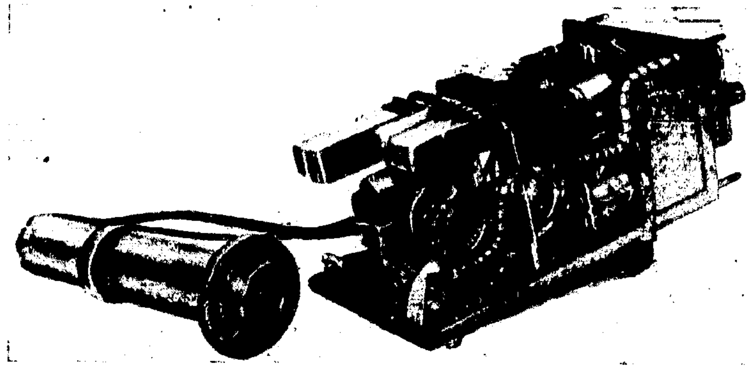

Fig. 12 - Apparatus for measuring ionic composition (mass-spectrometric tube and electronic block).

Measurements on the satellite show, that atmosphere with perceptible density extends to considerably greater altitudes, than it was previously assumed.

Determination of the upper atmosphere degree of ionization:

Electrons, forming in the upper atmosphere with ionization, play an important role in the propagation of radio-waves to great distances. The upper atmosphere layers with high content of electrons are like mirrors, which reflect radio-waves and thereby ensure their propagation beyond the direct visibility. Trajectories of radio-waves, which pass through these layer, become curved. Until now the ionization of the upper atmosphere was investigated by reflection from ionized layers of radio-waves, sent out by special radio-probing stations. However, in that way it was possible to investigate only regions below that with maximum content of electrons, i.e. upto altitude of 300 km. Higher layer were found to be inaccessible for this investigation method.

By means of a geophysical rocket of the Academy of Sciences of USSR, launched 28th Feb. 1958, it was possible to elevate radio-transmitters above the region with maximum ionization. Investigation of their radio-signals, received by ground stations, permitted to determine concentration of electrons upto altitude of 473 km. It was found, that above the maximum of ionization the electronic concentration drops very gradually. From altitude of 290 km, where it is maximum, to altitude of 473 km it drops by not more than half.

The third artificial satellite was equipped with a special apparatus, having traps of positive ions. It permits to determine spatial and time variations of ionization. Above the surface of the satellite were set up two reticular spherical ion traps, inside which was a spherical collector at negative potential in relation to the satellite's shell. The reticular sheath of the traps were periodically fed with short voltage impulses relatively to satellite body. During this volt-amper curves were taken of the current passing through collector trap, from the potential of its reticular sheath. Processing of these volt-amper curves permits to determine, besides the positive ions concentration, the satellite's potential in relation to surrounding matter, which in turn permits to estimate temperature of electrons in the upper atmosphere.

Very extensive material was obtained by means of the third satellite. It was fixed, that ionization distribution is similar to those data, which were obtained by means of rockets. However, since the recording by means of satellites was carried on for longer time and above various areas of the Earth, the obtained material is more extensive, than the few rocket data. These results are of considerable interest. Thus, it was found, that the temperature of ionospheric electrons is much higher, than that of neutral particles and ions at these altitudes. This is unexpected result, which requires further study and explanation. Just now it is only possible to put forward various hypotheses to explain this previously unknown phenomenon in the upper atmosphere. It is quite possible, that the high electronic temperature is due to existence of variable geomagnetic fields. Further study of this phenomenon will enable to comprehend better the laws, controlling ionospheric processes.

The measured negative potential of the satellite at altitude 795 km during daytime was found to be about 6 volts, and the concentration of positive ions at the same altitude - in the order of 160 thousands of ions per cu.cm. At an altitude of 242 km the potential of the satellite was about 7 volts, and the concentration - half a million ions in a cubic cm.

Measurements of electrostatic fields:

Measurements of the intrinsic electric charge of the satellite and intensity of electrostatic fields in the upper layers of the atmosphere were conducted by means of two electrostatic fluxmeters (highly sensitive electrometric devices), data units of which were set up at symmetrical points on the surface of the satellite. Each of the data units consists of insulated measuring plate, which opens and closes 1500 times per second by means of a special shield, connected with the satellite's body.

In the presence both of the external electrostatic field and intrinsic charge, there is flow from the plate of current, which on resistance, connecting measuring plate with the satellite body, induces variable voltage, proportional to measurable quantities. This voltage after amplification and rectification, done by means of two-channel electronic block is fed into the input of telemeter. By means of control signals from the programming device it was possible to check during the flight of the satellite functioning of the instrument.

Since the external electrostatic field and the field of intrinsic charge are added up at the point of one of the data units, and at point of another data unit substracted, than from the measurements, conducted by both data units, it is possible to calculate both the intensity of the atmosphere's field and the value of the satellite's intrinsic charge.

Control measurements during the flight of the satellite establish the fact, that the applied apparatus was operating normally.

Measurements of the satellite's electrostatic charge have shown, that the satellite acquires a negative change. The intensity of electrostatic field close to the walls of the satellite was considerably higher than expected. If it is assumed, that the charging of the satellite is bound with thermal speed of electrons and concentration is taken into account of the charged particles obtained from measurements on the satellite, the temperature of electronic gas at these altitudes should considerably exceed the temperature of neutral gas, which confirms data, obtained by device for measuring concentration of ions.

Unexpectedly high was found to be the measured intensity of the field in the upper layers of the atmosphere. Its value is at least 10-100 times above the expected. This fact, which may be the key to understanding many processes in the atmosphere as, for instance, causes of its ionization at night, needs further experimental checking and detailed study.

Magnetic measurements:

On the third Soviet artificial Earth satellite were accomplished for the first time the geomagnetic measurements, the main object of which is the spatial distribution investigation of the constant magnetic field of Earth at high altitudes and comparison of the spatial distribution of uniform intensity lines of magnetic field and uniform intensity lines of cosmic rays.

The geomagnetic measurements on the satellite is an extremely difficult problem, since the large number of devices, set up in it, created considerable difficulties for precise intensity measurements of magnetic field, connected with magnetic deviation, induced by the board apparatus. Therefore it was necessary to take special measures for elimination and estimate of magnetic deviation. The same condition imposed certain limitations also on the selection of magnetometer, by means of which the geomagnetic measurements were conducted on the third artificial Earth satellite.

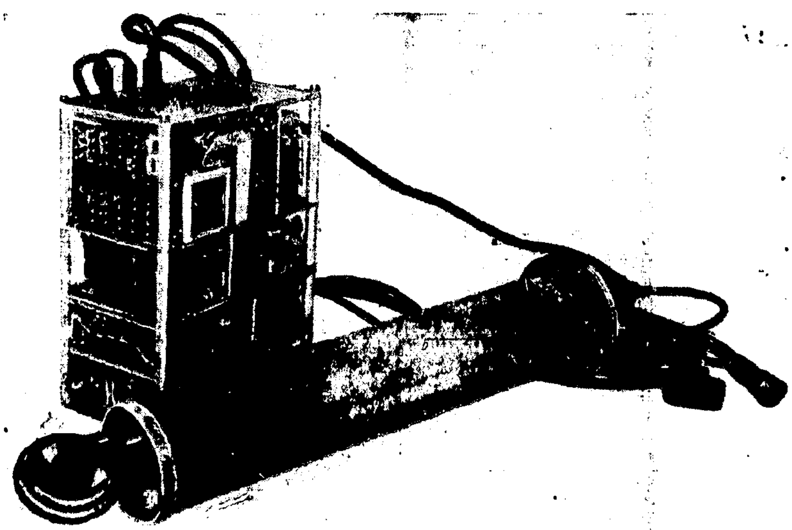

Fig. 13 - Apparatus for measuring magnetic field of the Earth (orientation node and electronic block).

Magnetometer is a device, the measuring unit of which is automatically oriented in direction of the total vector of the Earth's magnetic field at any orientation of the satellite, The measure of magnetic field and its variations is the compensation current, passed through along a coil, set up on the measuring unit, in such a direction, that it will fully compensate the Earth field in a volume, taken up by the unit.

Two potentiometric units, set up on the orientation node of magnetometer, made it possible to determine the position of the satellite's body in relation to Earth field and the speed of its rotation around its own axis.

Magnetometers of this type are less sensitive to heterogeneities of magnetic field and electromagnetic interferences. Heterogeneity of the field and variable interferences affect the stability and accuracy of magnetometers performance, but do not prevent formation of the signal.

As a result of obtained material processing it is possible to draw a number of conclusions.

From the data of potentiometric units of the magnetometer's orientation node it is possible to obtain the exact motion pattern of the satellite close to its own gravity centre. The satellite, rotating around its own axis with speed of about 0.36 degrees per second, performs at the same time precession movement around the axis stationary in space with period of 140 seconds. From the available data it is possible to determine the absolute orientation of the satellite in space with respect to the determined system of coordinates.

Due to precession nature of the satellite's motion it seems possible to exclude the basic part of the deviation error, bound with the apparatus, which surrounds the magnetometer. This effect of the board apparatus was determined experimentally in laboratory conditions. Knowing the maximum magnetic deviation, it may be assumed, that the satellite's magnetometer measures realistically the intensity of the Earth's magnetic field and projection of the magnetic interference vector for direction of the Earth's magnetic field.

Analysis of magnetograms, pertaining to the territory of East-Siberian magnetic anomaly, shows, that this anomally dampens with altitude very gradually. This experimental fact goes against the geophysical hypotheses, based on the assumption, that the sources of this continental anomally lie within the top layers of earth crust.

Revision of material permits to discover also singular points characterised by comparatively brief, but quick variations of magnetic field. In time they coincide with the passage of the satellite through layer F_2 of ionosphere.

There are grounds for assuming, that the discovered quick variations of magnetic field may be connected with the assumed current systems in the upper layers of the atmosphere. The authenticicity of this assumption should be checked by analysis and statistics of the whole experimental material. The question regarding the reality of current systems existence has an exceptional significance for many problems of geophysics and astrophysics.

Investigation of meteoric particles:

For investigation of meteoric particles on the third Soviet satellite the application was of apparatus, which permits to record both the number of particles impact on the surface of apparatus and their energy.

Meteoric particle, rushing at speed of 11-70 km/sec, when falling into an obstacle - measuring device - explodes. Therefore its impulse cannot be measured, and the impulse, which is recorded, is of the data unit material, ejected with explosion.

Theoretical estimate has shown, that for high speed impulse, obtained by the measuring device with explosion, is proportional to the energy of meteoric particle and depends on material of the unit's surface.

Impulse measuring was accomplished by means of ballistic piezoelectric pickup, which is a massive plate, suspended on a flat spring, connected with which are four piezoelectric cells of ammonium phosphate.

The shifting of plate under the impact of meteoric particle causes deformation of piezoelectric cells with issue of electric voltage in the form of short-period damping oscillations, recorded by transformer amplifier, which estimates the number of impulses in separate amplitude intervals.

The piezoelectric pickups measure impulse acting on their surface in the range from 0.1 to 1000 grams per centimeter per second. The ultimate sensitivity of the measuring apparatus permits to record impacts of meteoric particles with masses of one billionth fraction of a gram at average speed of 40 km per second.

Piezoelectric pickups with total area of 840 sq.cm. recorded on an average one impact for over 100 sec. This corresponds to density of meteoric matter less than ten-billionth fraction of gram per second per square metre of surface. Besides this density of meteoric matter the recording was also of brief high increment of the number of impacts, reaching several scores per sq.m. in second. The recorded meteoric particles and energies in the order of ten thousands ergs.

Study of cosmic rays:

The study of cosmic radiation provides the possibility of obtaining progressively new information regarding the inception of particles with very high energies. Even the first tests on the second artificial Earth satellite on the study of cosmic rays produced interesting results. On the third satellite the devices for cosmic rays study were more complex and made it possible to record, besides the charged particles, photons and heavy atomic nuclei in the cosmic radiation.

The luminescent counter on board permitted to record photons with high effectivity. The main section of device was the photoelectric multiplier, connected with sodium iodide crystal. This device was attached to radio-transmitter "Mayak", which transmitted into other the data on total ionization in crystal and counted number of impulses, corresponding to energy of over thirty five thousands electric volts separated in the crystal. These values were transmitted by changing duration of signals sent out by "Mayak".

The luminescent counter has recorded sudden change in the number of photons on reaching about 60°N. Initially with the motion south to north the intensity composed 300-500 photons per second, thereafter it sharply increased. With the motion north to south, on the contrary, initially the intensity was very high, but on reaching the mentioned latitude it quickly decreased. This change indicates, that above 60°N there is a new intensive source of photons. This latitude is near the zone of polar lights, and it is only natural to explain this phenomenon as connected with the polar lights.

If composition of particles, causing the northern lights, includes electrons with energy of some hundreds of thousands electron volts, the falling of these electrons on the sheathing of satellite results in formation of rigid X-ray radiation, recordable by scintillation counter,

Measurements have shown, that even higher intensity flux of charged particles is observed in the area of equator. The intensity of this flux sharply increases with altitude and on approaching the equator. The number of particles in this flux is very high. It is thousand times the number of particles in the cosmic rays flux.

Thus, it is found, that the Earth is as though surrounded by an aureole of quickly moving particles, held-in by the Earth's magnetic field.

Similar phenomena may be observed in other heavenly bodies with magnetic field.

Device for measuring the amount of heavy atomic nuclei in primary cosmic radiation, set up on the third Soviet satellite, recorded nuclei, starting with charge of over 16, and for another group of nuclei - with charge of over 30. Counter used in device consisted of photoelectric multiplier and plexiglass detector. This counter recorded only the atomic nuclei with energy exceeding 300 million electric volts per component part of the nucleus (proton or neutron).

On the basis of processing the reading of device the number of atomic nuclei with charge of over 16 was estimated in individual time intervals. Average number of these atomic nuclei composed.

1.2 nucleus per minute. There was only one case of nucleus recording with charge over 30. These data are most essential for developing theory of the cosmic rays origin.

According to the data obtained in performance of the counter, the number of atomic nuclei heavier than iron in cosmic radiation was found to be approximately ten thousand times lower in comparison to the number of iron, nickel and cobalt nuclei.

Composition and ratio of various atomic nuclei in cosmic radiation is, generally speaking, bound with abundance of chemical components in the Universe. Tentative results, obtained on the third satellite, confirm the opinion, that flux ratio of very heavy nuclei with charge of over 30 and of those with charge over 16 corresponds approximately to the ratio for these nuclei, taken from the data of the composition analysis of planets, stars and meteorites.

Investigation of corpuscular radiation:

The ionization of the upper atmosphere is usually caused by the rigid electromagnetic radiation of the Sun. However, it has been established, that additional ionization originates from the corpuscles - fast protons, alpha-particles, electrons, etc. The effect of corpuscles is more intensive at high geomagnetic latitudes. If their penetration is accomplished at night, then simultaneously with increased ionization there is the development of the so called polar lights. It was fixed from the spectrum of polar lights, that amohg the corpuscles are also particles such as ions and hydrogen atoms, helium atoms. A number of polar lights spectra could have been explained electrons not very fast. Study of the polar lights permitted to assume, that in the outer Earth atmosphere due to variable magnetic field, induced by the interplanetary matter and cospuscular flux of the Sun, the intrinsic atmospheric electrons may accelerate. With irradiation by these accelerated electrons of the satellite's body there should have originated X-rays and these were recorded by the scintilation counter.

For recording of corpuscles on the third artificial Earth satellite the application was of fluorescent screens, similar to those, in cinescopes of television. These screens were covered by aluminium foil of different thickeness. Radiation of the screens was recorded by photoelectric multipliers. Their signal was transmitted to memorising telemetric device. By means of this apparatus recordings were made of high intensity electronic flux. Sometimes the intensity was so high, that it exceeded the upper meausirng limits of the apparatus. In these conditions the reading of the device was off-scale. There were seldom no signals on the threshold of sensitivity. When the apparatus was not off-scale it was possible to assume from the signal ratio from indicators with various thickness of foil, that the energy of electrons was upto 10 thousands of electron volts. At the moment of device being "off-scale" the energy could have been even higher. If the electrons are assigned the above energy, the flow of energy at the threshold of sensitivity composed one millionth fraction of the total solar energy, falling onto one square centimetre of earth surface. At the "off-scale" moment of device this energy increased to one thousandth fraction. The intensity of electronic flux continuously varied: it increased with altitude and above high geomagnetic latitudes. These electrons could not be the direct solar corpuscles, since their speed is many times that, fixed for solar corpuscles from the observation of polar lights. They could most likely be explained by the above acceleration of electrons in the outer atmosphere due to variable magnetic fields.

It is not without interest to mention, that the device for recording of cosmic photons could not register these particles due to high-intensity interference with X-rays, produced by the irradiation of satellite's body by hard electrons. This device instead of giving information regarding cosmic photons provided valuable additional information regarding particularly the hard electrons of the outer atmosphere, the existence of which previously was a subject of critical doubt.

The discovered phenomenon is of considerable interest for the physics of the upper atmosphere. It may explain a number of anomalies in ionosphere and be the additional source of the upper atmosphere heating above the polar regions of the Earth.

Results of solar batteries performance.

Prolonged carrying out of many scientific experiments on the artificial Earth satellite is precluded by the capacity of current sources. Therefore the experiment of using solar batteries as a new source of supply is specially significant.

On the third artificial Earth satellite, besides the solar batteries, meant for the power supply of radio-transmitter "Mayak", were also set up experimental solar batteries, which made it possible to clarify their operating conditions in cosmic space.

These batteries, consisting of a great number of silicon photoelectric cells, transform solar radiation directly into electric power. Silicon photoelectric cell is a thin plate (less than 1 mm in thickness) of ultrapure monocrystalline silicon. It consists of two regions with opposite conduction mechanisms. Solar energy conversion factor of the photoelectric cell is 9-11%, and the voltage of one cell is about 0.5 volts.

The experimental solar batteries are arranged on the two opposite sides of the satellite' body. From their reading determination was made of the meteoric erosion rate and temperature variation of the solar battery in the sun or in the shade. Observations have shown, that according to estimates the mean temperature of the silicon transformers fluctuated between 16 and 30°C. Thus, with rationally implemented construction there is no danger of photoelectric cells being damaged by overheating. Processing of data, connected with meteoric erosion indicates, that the wear out of covers, protecting solar batteries is very gradual and cannot be the cause of their getting out of order too quick.

The performance of radio-transmitter "Mayak", energized upto the present from solar batteries, confirms, that cosmic irradiation is, apparently, of no great danger to solar batteries. Solar battery for the power supply to "Mayak" was disposed in the form of separate sections on the surface of the satellite. Four small sections were set up on the forward bottom, four - on the lateral surface and one - on the rear bottom. All sections were connected in parallel through diodes.

During the passage of satellite in sun-rays the supply of radio-transmitter is from the solar batteries. During the motion of satellite in the shadow of the Earth the transmitter is fed from electrochemical sources of current. The change-over from one power to another is automatic.

Positive results of experiment on direct transformation of solar energy into electric outside the Earth's atmosphere, conducted on a large scale on the third Earth satellite, are highly significant for assuring working conditions for a scientific devices during a prolonged period.

Investigation results, obtained by means of the third Soviet artificial Earth satellite, have considerably extended our knowledge of the upper layers of the atmosphere and adjacent cosmic space. For the first time with help of the finest devices Man has conducted investigations in the previously inaccessible regions of the Universe.

These investigations have now changed our concepts regarding the upper layers of the atmosphere.

The highest merit of the Soviet scientists is that they were able to create powerful satellites, equipped with perfect scientific apparatus, reliably operating in the conditions of cosmic flight.

"Pravda", 5 October, 1958.

10,000 REVOLUTIONS AROUND THE EARTH:

By 6 a.m. of April 3 the third artificial satellite completed 9982 revolutions around the Earth:

To-morrow, the 4th of April, the third Soviet artificial Earth satellite will complete its ten-thousandth revolution around the Globe. By then it will fly 446.6 million kelometres, being in flight 689 days.

The time of existence the third satellite has considerably exceeded its forerunners. As we know, the first in the world artificial Earth satellite, constructed by Soviet scientists, engineers and workers and which has ushered in a new era in the development of science and technique, existed for 94 days, completing 1440 revolutions arou id the Earth, and the second 163 days, completing 2370 revolutions.

The weight of the third satellite - 1327 kg - is almost sixteen times th'weight of the first satellite, and in its efficiency the third satellite is unexcelled until now.

The heavy weight of the third satellite, which enabled to set up in it complex and different apparatus, reliability and stable performance of this apparatus in conditions of launching and flight, high efficiency of power sources on board made it possible to accomplish by means of this satellite important and fine investigations during a prolonged time.

Finally, an appreciable greater altitude at apogee of the third satellite in comparison to the first two enabled to obtain new data at altitudes, previously never attained.

When the third satellite was placed into orbit its altitude at apogee was 1880 km, at perigee 226 km, and the revolution period was 105.95 minutes. By the fifth thousandth revolution, on the 8th of May, 1959, revolution period of the third satellite became reduced to 99.51 minutes, and the altitude at apogee de reased by 605 km, reaching 1275 km.

During the second five thousand revolutions, due to the motion of satellite in high density layers of the atmosphere, changing of its orbital parameters was much faster.

By the 4th of April the period of revolution will get reduced to 88.60 minutes and the altitude at apogee will come down to 230 km.

The perigee of the satellite's orbit will also decrease considerably, coming down to 165 km. The reduction of orbit and its approach to the ciruclar was occurring at particularly high rate during the last month of the satellite's existence.

From the 28th of March began sharp retardation of the satellite's motion and its entry into considerably denser layers of the atmosphere.

On the basis of the carried out calculations it is expected, that the satellite will cease to exist between 4-6 April of the current year.

By means of the third Soviet satellite extensive investigations were conducted of cosmic rays, corpsucular radiation of the Sun, magnetic field of the Earth, ionosphere structure, distribution study of density and pressure in the upper layers of atmosphere, meteoric particles and the propagation of radio-waves.

An important scientific result, obtained in the study of cosmic radiation by means of the third satellite, was the discovery of the outer radiation belt and detailed study both of internal and outer belts. As we know, the first information regarding the existence of the outer radiation belt of the Earth was obtained in the flight of the second Soviet artificial satellite.

In the flight of the third satellite above the 65° area of the geomagnetic latitude in the northern and southern hemispheres it intersected the zone of higher radiation, specified by electrones with energy of tens and hundreds thousands of electron volts. This type of radiation was not observed in low latitudes and in the areas of geomagnetic poles, which is possible only in the case, if the electrones are locked in a trap, built up by the magnetic field of the Earth. This conclusion, based on the observations of the third satellite, was later on confirmed by data, obtained in the flights of Soviet cosmic rockets.

Even before the launching of the third satellite an intensive cosmic radiation was discovered above the equatorial areas. However, what was this radiation and how it is distributed in space, was at that time unknown. These questions were for the first time answered by the devices of the third Soviet satellite. It was proved, that the equatorial internal radiation belt of the Earth consists of portons with energy tens and even hundreds of millions of electron volts.

Besides, interesting data were obtained on distribution of heavy nuclei in the primary cosmic radiation.

Apparatus was set up on the third satellite for discovering particles of low energies by means of which it was possible to discover the electron flux with energy of about 10 kilovolts. Considerable portion of these electrons is repelled with motion toward the Earth due to the existence of a geomagnetic barrier. Electrons, capable of reaching ionospheric layers induce additional ionization of heating of the upper atmosphere. Discovery of this electronic flows throws a new light on the nature of polar lights.

New data were obtained by means of the third satellite on the constant magnetic field of the Earth. Discovery was also made of short-duration quick changes of magnetic field. Because of this, valuable material was obtained for investigating the so called current systems of the upper atmosphere.

New data were obtained in the measurements of atmospheric density. Observation of the third satellite's decelaration enabled to discover, that density of the upper atmosphere at levels above 200 km is considerably higher, than previously assumed. Moreover the braking speed itself of the satellite was found to be irregular. Variations of the upper atmosphere's density and temperature were defined. It has established, that its lighted portion is denser and hotter, than the unlighted, and that density and temperature of the upper atmosphere above the high-latitude areas depend to a considerable extent on the solar activity.

The use of improved ionization and magnetic discharging gauges enabled to determine by direct measurements pressure and density distribution in the upper atmosphere upto altitude of 500 km.

The mass-spectrometer measurements on the third satellite made it possible to obtain material on ionic composition of ionosphere in a wide range of altitudes.

Measurements have shown, that daytime at altitudes from 225 to 1000 km the predominance in ionosphere is of elementary oxygen ions. Discovery was also made of molecular ions of nitrogen, nitric oxide, oxygen and ions of elementary nitrogen. The content of molecular ions quickly drops with increasing altitude and, starting from 500 km, the ionosphere becomes elementary. It was fixed, that composition of ionosphere depends on latitude.

Prior to the launching of the third satellite direct concentration measurements of charged particles were conducted only upto altitude of 470 km (on the high-altitude geophysical rocket of the Academy of Sciences of USSR, launched 21 February 1958). By means of ionic traps set up on the third satellite, determination was made for the first time of ionic concentration upto altitude of 1000 km, where it was found to be 60 thousands of ions per cu.cm. Data were obtained regarding dimensions of ionic heterogeneities at different altitudes.

Measurements on the third satellite defined, that the so called meteoric danger is not high.

Considerable role in the investigations of ionosphere, confirmation of its characteristics and study of radio-waves propagation were played by the radio-observations of the transmitter "Mayak", set up on board of the third satellite. The reception and recording of its radio-signals were maintained by many scores of Soviet and other countries scientific stations, throughout the Globe.

The long and steady performance of the transmitter "Mayak" has enabled to follow the propagation of signals, emitted by it from the most diverse altitudes, at any time of the day and year and at any point of the Globe.

These investigations has made it possible to obtain new information regarding the so called irregular changes in ionosphere.

Discovery was made of the satellite's radio-signals "flicker". As a result of processing numerous experimental data, Soviet investigators defined, that this flicker is caused by the heterogeneities of ionosphere. These non-uniformities form a clearly defined latitudinal belts; the connection was fixed of the radio-signals flickering with other geophysical phenomena. The nature was defined of the flicker's dependence on the period of the day and on the altitude.

Recording of radio-signals from the transmitter "Mayak" enabled to obtain new information regarding concentration of electrons in the outer ionosphere. According to data, obtained by meansof the first satellite, it was found, that electronic concentration in the outer part of ionosphere is considerably denser, than was previously assumed.

Most significant and interesting are the results obtained by a long use in cosmic conditions of solar batteries on board of the third satellite, which are the most promising sources of electric power for cosmic objects. Non-stop performance of the solar batteries from the moment of the satellite's launching confirmed the correct construction and rationality of arranging separate sections on the satellite.

Measurements conducted by means of the third satellite could have been processed only on condition of knowing exactly at what altitude, latitude and longitude was the satellite at every moment.

To determine parameters of the satellite's motion a special automatic measuring complex was developed on the ground equipped with the latest radio-technical apparatus. Determination of the ortital elements of the satellite is conducted on quick-action electronic computers. Operation of this measuring complex to determine characteristics of the third satellite's orbit during the period of the highest amount of measurements with accuracy, far in excess of the motion parameters measurement of the first two satellites.

In the third satellite's observations highly significant were also the other radio-technical and optical means. About 90 optical stations and observatories on the territory of the Soviet Union and over 110 such stations abroad constantly maintained and still maintain observations and regularly send the results addressed to "Moskva-Kosmos". Besides, about 400 other foreign stations in 33 countries conduct ocassional observations and send their data to the Astronomical Council of the Academy of Sciences USSR.

Regular observations of the third satellite are being conducted by tens of thousands of Soviet and foreign radio-amateurs and observers.

In order to estimate the volume of carried out measurements and observations it is sufficient to say, that during the existence period of the third Soviet Earth satellite the coordination and computing centre has issued about 5,000 ephemerides to Soviet observation stations and over 46000 - to foreign stations. Received and processed during the same period was over 127000 bearings of the board transmitter "Mayak", about 28500 results of optical observations conducted by Soviet stations and about 19800 sent-in by foreign station.

There is a special significance and interest in the observations of satellite during the last period of its existence, its entry into the denser layers of atmosphere. Conditions study of the satellite's flight in dense layers of the atmosphere is, in particular, most essential for construction of cosmic apparatus, which willhhave to return to the Earth. At this last stage of the satellite's existence, when due to the sudden change in parameters of its orbit observations of satellite become difficult, a greater number is additionally involved in the observations of radio-technical, optical and other means.

From the moment of launching and till the last days of its existence the third Soviet satellite has incited an enormous interest of the Soviet people and foreign citizens.

During this period thousands of letters were received at the address "Moskva-Kosmos" and "Moskva-Sputnik" from Soviet citizens and from abroad, containing results of observations, various questions, suggestions for improvement of apparatus observation methods and admiration is expressed of the outstanding achievements of the Soviet science and technique in the investigation of cosmic space.

Results of investigations, accomplished by means of the third satellite have appreciably enriched our knowledge of the upper layers of the atmosphere, cosmic space and lead to new discoveries of high significance.

"Pravda", 3 April, 1960.

TASS COMMUNIQUE

IN ORBIT - SOVIET HEAVY EARTH SATELLITE. ITS WEIGHT - 6483 KG.

In accordance with the plan of constructing and producing spacecraft of high weight on the 4th of February 1961 in the Soviet Union the launching of a heavy artificial Earth satellite by means of a a multistage rocket, has been accomplished. The weight of satellite, not counting the last stage of the carrier-rocket, is 6483 kg. The satellite contains radio-telemetric system for parameter checking of construction details and the apparatus for trajectory measurements. The whole apparatus abroad the satellite functioned normally in the section of its placing into orbit and in further motion along it.

Tentative data, obtained by means of the measuring-computing complex on the ground, permitted to determine the following parameters of the satellite's orbit: revolution period 89.80 minutes, altitude at perigee 223.5 km, altitude at apogee 327.6 km, dip, of orbit 64°57'.

The measured parameters of the satellite's orbit are close to the calculated one.

Scientific and technical problems, preset at the launching of the satellite were accomplished.

"Pravda", 5 February 1961.

TASS COMMUNIQUE REGARDING THE LAUNCHING IN THE SOVIET UNION OF MANEUVERING SPACECRAFT: "POLET-1"

In accordance with the program of mastering cosmic space and further improvement of space craft the development of space-craft which would enable to implement during the orbital flight extensive maneuvering in every direction is being conducted in the Soviet Union.

The work being conducted will permit to resolve the problem of the space-craft flight control, directing them into required areas for obtaining scientific information in connection with investigations of cosmic space.

In order to implement this program launching was carried in the Soviet Union on the Ist of November 1963 of controllable maneuvering spacecraft "Polet-1", equipped with special apparatus and system of motors, assuring its stabilization and carrying out of extensive maneuvering in the circumterraneous outer space.

Set up on board of spacecraft is scientific apparatus, radio-telemetric system and transmitter, operating on frequency 19.945 megacycles.

The space-craft was placed into orbit with altitude at apogee 592 km and at perigee 339 km.

In full conformity to the fixed program multiple switching was implemented of motors for stabilization and subsequent space maneuvering of the space-craft.

The space-craft "Polet-1" completed considerable lateral maneuveres, varying the plane of the orbit, as well as maneuvres in altitude and changed over to the final orbit with dip to equator plane 58°55', with altitude at apogee 1437 km and at perigee 343 km.

The initial revolution period of this space-craft in the orbit is 102.5 minutes.

Apparatus aboard the space-craft operates normally.

Observation of the space-craft "Polet-1" and reception of telemetric data are being conducted by controlling and measuring ground stations on the territory of the Soviet Union.

The radio-telemetric instruments assure transmission of the required scientific information, connected with investigations of cosmic space.

Thus, accomplished for the first time was the multiple widespread maneuvering of space-craft in the outer space.

As a result of accomplishing the planned program of tests an important step was made in the Soviet Union for further study and mastering of the outer space.

"Pravda", 2nd November, 1963.

TASS COMMUNIQUE ON THE LAUNCHING IN THE SOVIET UNION OF MANEUVERING SPACECRAFT "POLET-2".

In accordance with the program of mastering the cosmic space a routine launching was carried out in the Soviet Union on the 12 April 1964 of controllable maneuvering spacecraft "Polet-2". The launching of this spacecraft was done with the aim of further perfecting of the spacecrafts, permitting to maneuver in every direction, and the working out of questions, bound with the resolution of the problem on the approach and meeting of objects in space.

To carry out maneuvering in space and flight stabilization, the spacecraft "Polet-2" is equipped with special control instruments and a system of engines.

Set up on board the spacecraft are the scientific devices, radio-telemetric system and transmitter, operating on frequency 19.895 megacycles per second.

After separation from the carrier-rocket and ballistic flight the spacecraft "Polet-2" was placed into initial orbit by means of a special engine and in accordance with the fixed program carried out multiple maneuvering in various directions. As a result of one of the maneuveres in the area of equator, the spacecraft has considerably changed the angle of the orbital plane.

After carrying out the whole maneuvering program the final orbit of "Polet-2" has the following parameters:

- inclination angle 58.06 degrees;
- altitute at apogee 500 km and at perigee 310 km;
- initial orbitol period 92.4 minutes.

During the flight multiple turns were implemented of the spacecraft and its orientation according to set program. A great number was switched on of rocket engines for continued stabilization and maneuvering of the spacecraft.

The devices and instruments on board the spacecraft operated normally.

The radio-telemetric instruments assure transmission of the required scientific information in connection with cosmic space investigations.

Observations of the spacecraft "Polet-2" and reception of telemetric data are being implemented by the ground command and measuring control points, located on the territory of the Soviet Union.

The launching of "Polet-2" in the Soviet Union means one more important step in the improvement of maneuvering spacecrafts and the mastering of cosmic space.

"Pravda", 13 April 1964.

TASS COMMUNIQUE ON THE LAUNCHING OF "ELECTRON-1" AND "ELECTRON-2".

In accordance with investigation program of upper atmospheric layers and cosmic space a successful launching was carried in the Soviet Union on the 30 January 1964 of a space system, consisting of two research stations (Earth satellites) "Electron-1" and "Electron-2", placed in considerably different orbits by a single powerful carrier-rocket.

Separation of the space station "Electron-1" from the carrier-rocket was carried out in the active section of the flight with operating last-stage engine.

After the separation of "Electron-1" the last stage of carrier rocket continued its flight in the set trajectory and, picking up the required speed, placed into present orbit the space station "Electron-2".

According to tentative data, the space stations are placed into orbits, close to calculated with the following parameters:

<u>Electron-1"</u> - altitude at perigee 406 km, altitude at apogee - 7100 km.

<u>"Electron-2"</u> - altitude at perigee - 460 km, altitude at apogee - 68200 km.

Orbital period of the stations is 2 hrs. 40 min and 22 hrs 40 min respectively.

Inclination of the orbital place of the stations is at 61 degrees.

Set up on board the space stations are the scientific instruments, radio-telemetric systems and radio-transmitters "Signal" and "Mayak", operating on frequencies 19.943; 19.954; 20.005; 30.0075; 90.225 mcps.

The main task in the launchinof space stations "Electron-1" and "Electron-2" is the simultaneous investigation of the internal and external radiation belts of the Earth and the connected physical phenomena.

The study of the Earth's radiation belts by means of the space stations will enable to obtain valuable scientific data on the nature, spatial position and energy spectrum of the charged particles.

Simultaneously study will be conducted of the various radiations, incoming from the outer space, and physical conditions in the upper atmospheric layers.

Observations of space stations "Electron-1" and "Electron-2" and reception of telemetric data are conducted by the ground points of command control system, located on the terrotory of the Soviet Union. The instruments on board are controlled by programers on board and by commands from the Earth.

The radio-telemetric information, received from the space stations "Electron-1" and "Electron-2", indicates normal functioningof all the systems. The coordination-computing center

Results of investigations, conducted by means of the two above space stations will be published with accumulation and processing of radio-telemetric information.

"Pravda", 31 January 1964.

NEW OUTSTANDING EXPERIMENT IN THE OUTER SPACE:

Press-conference of Soviet and Foreign Journalists in the Academy of Sciences USSR.

Great interest throughout the world was caused by the new outstanding experiment in space undertaken in the Soviet Union - launching of scientific stations (earth satellites) "Elektron-1" and"Elektron-2". This was the event discussed at the press-conference of Soviet and foreign journalists, arranged yesterday by the Academy of Sciences, USSR, Ministry of Foreign Affairs, USSR and State Committee of the Council of Ministers, U.S.S.R. on Cultural Association with foreign countries.

The press-conference was inaugurated by M.V. Keldysh, President of the Academy of Sciences.

ADDRESS OF M.V. KELDYSH, PRESIDENT OF THE ACADEMY OF SCIENCES, U.S.S.R.

Dear comrades, gentlemen!

On the 4th of October, 1957 Soviet science and technique have opened the way into the outer space. The first in the world artificial earth satellite has been placed into orbit. The historical stage has begun in the systematic investigation of the outer space. The new most important landmark along this way were the flights of Soviet moon rockets, which gave to science discoveries of fundamental significance - photographs of the reverse side of the moon and the proof of absence on the moon of a significant magnetic field.

The greatest contribution of Soviet scientists, constructors and engineers into further study of the outer space was the accomplishment of the first in the world manned flight into the outer space.

Earth satellites and automatic interplanetary stations have become firmly established in the arsenal of technical means for investigation of the outer space and of the solar system planets. All this has resulted in the new science - space physics.

At present important information has been obtained regarding the structure of the upper layers of the atmosphere and its density and pressure with activity of the Sun, discovered the so called "ionized geocorona", extending to distances of 20,000 km, for the first time experimental recording made in the interplanetary space of the flux of corpuscles, ejected by the Sun, data have been obtained on the structure of the Earth's magnetic field to distances of several earth radii, planetary map plotted of the intensity distribution of cosmic radiation at altitudes 220-300 km and region discovered of anomalously high radiation intensity in the area of Brazilian magnetic anomaly, etc.

One of the most bright achievements in the study of circumterraneous space is the discovery of the Earth's radiation belts, which were found to be a highly composite formation both in their nature and in their structure.

The mechanism of their inception is upto now unknown. A whole complex of composite physical processes, to which they owe their existence, requires new tests. The specific feature of these tests is the simultaneous measurements at various points of the circumterraneous space.

This problem required construction of a special space system, consisting of several satellites, placed into substantially differing orbits. The "Electron" space system is the first.

By means of a powerful carrier-rocket it was possible to place into orbit with altitude at apogee 7000 km scientific station "Electron-1" and with altitude at apogee 70,000 km station "Electron-2".

On these stations simultaneous implementation is being conducted of the earth's radiation belts and the related physical phenomena according to a single program. This program envisages investigation of high and low energy particles in the earth's radiation belts, the earth's magnetic fields and radiation belts, cosmic rays, chemical composition of the circumterraneous space, short-wave radiation of the sun and radio-emission of galaxies, micrometeorites. The construction for the indicated investigations in the International Geophysical year, when the sun was calm and which started from 1st of January 1964, attaches a high significance to this experiment.

The obtained results will be widely published in the scientific press and will be contribution of Soviet Scientists into program implementation of the International Year of Quiet Sun.

The object of the present press conference is to acquiant the World public with the scientific aims of the system of the space stations "Electron-1" and "Electron-2".

And now may I present the scientists, who will describe these aims: S.N. Vernov, Associate of the Academy of Sciences USSR, K.I. Gringaus, Doctor of Technical Sciences and Yu. D. Kalinin, Doctor of physico-mathematical Sciences.

Address of S.N. Vernov, Associate of the Academy of Sciences, USSR.

The first flights of the satellites have resulted in the discovery of new, hitherto unknown to science nature's phenomena - radiation belts of the Earth.

It was possible to elucidate, that the circumterraneous space has a composite structure. There is existence within it of two zones, filled with high-intensity fluxes of charged particles. These zones were denoted as the radiation belts of the Earth. At great distances from the Earth (10 times the size of our planet) exists an outer radiation belt of the Earth, discovered during the flight of the third Soviet satellite. Even now (i.e. more than five years after its discovery) the outer radiation belt is still a mystery.

Besides the outer radiation belt of the Earth, there is an internal radiation belt, discovered during the flights of American satellites.

Immediately after dhscovery of the internal radiation

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belt in USSR, and thereafter in USA hypothesis was put forward regarding the origination mechanism of the internal belt. This hypothesis explains very well the experimental facts regarding nature and energy spectrum of particles within the internal radiation belt.

An entirely different picture is observed in the study of the outer radiation belt. It may be taken as fixed, that the origination mechanism of the internal belt cannot explain the existence of the outer belt. This was proved in 1960 in the flight of Soviet space-craft. Apparently, in the vicinity of the Earth at distances of thousands and tens of thousands km operates unique "cosmic accelerator" of particles.

To explain the nature of the "cosmic accelerator" requires simultaneous investigation of many physical phenomena in the space close to Earth. This necessitates construction of a space system, consisting of a number of satellites, conducting simultaneous measurements at various points of the space adjacent to Earth.

Launching of the scientific satellite-stations "Electron-1" and "electron-2" is the beginning of such a system. Investigations conducted upto now have shown, that with the Earth's getting into the corpuscular flux, erupted from the Sun, i.e. with the appearance on the Earth of magnetic storms and polar lights, high-intensity changes occur in the outer radiation belt of the Earth. It means, that precisely at this time begins operating the "circumterraneous cosmic accelerator".

The main problem, which should be resolved in the flights of"Electron-1" and "Electron-2" is the study of the internal and outer radiation belts of the Earth and the related physical phenomena.

Aboard of both the satellites is an identical apparatus for measuring electrons and protons of various energies. These measurements should enable to determine simultaneously at two points of the circumterraneous space composition of emission in the radiation belts. The study by means of "Electron-1" is of the internal radiation belt of the earth and the nearest to Earth "spurs" of the outer radiation belt, at the same time the scientific station-satellite "Electron-2" cuts through the outer radiation belt and passes beyond it into interplanetary space, where the particles of radiation belt should not be present and the main type of radiation are the cosmic rays.

The presence of identical apparatus on both the satellites makes it possible to depict the picture of the radiation belts disposition in space and to tie-in the measurements, implemented by various satellites at different distances from the Earth.

An extensive set of various devices permits to study in detail composition of radiations, to determine nature and energ spectrum of particles, which make up composition of the radiation belts.

Various and abundant information is being received from "Electron-1" and "Electron-2". Data obtained at present show, that the scientific instruments function normally.

Moscow agreement on banning nuclear tests in the outer space assures possibility of studying radiation belts without interference from nuclear explosions in the outer space.

Address of K.I. Gringaus, Doctor of Technical Sciences.

I would like to draw your attention to the region directly beyond the radiation belts, which, undoubtedly, has a high geophysical significance, but even considerably less known, than the radiation belts. I'am talking about the existence zone of high intensity flux of comparatively - low-energy electrons, the so called outermost belt of charged particles.

Measuring results of currents, recorded in charged particles traps on the first Soviet Moon rockets of 1959, have shown, that after the exit of rockets from the outer radiation belts the traps began recording fluxes of electrons with energies from 200v to 10-20kv, exceeding in magnitude the electron fluxes in the outer radiation belt at least 10 times.

Subsequently investigations of the above zone were continued by means of satellites and space rockets both in USSR and in USA. Magnetic measurement have shown, that magnetic field in the region of the outermost belt of charged particles continuously varies both in size and in direction. This indicated, that the electrons in this zone were not captured by the magnetic field of the Earth, since the magnetic trap for charged particles cannot exist here. Apparently, the electron fluxes of the outermost belt are able to affect most intensely the upper atmosphere, by entering it at high latitudes.

Is the outermost belt of charged particles completely closed, i.e. does it exist in direction, opposite to Earth-Sun direction. This question will, naturally, arise, if we proceed on the assumption, that the outermost belt originates from the flux of solar plasma.

Although the combination of tests, carried out upto the present time, does not permit as yet to give a final answer to this question, it still gives grounds for assuming, that this belt is completely closed. The correctness of this assumption is indicated, in particular, by the results of measurements on the station "Mars-1".

Measurements conducted on "Electron-2" should substantially supplement the information available at present about the outermost belt of charged particles.

Address of Yu. D. Kalinin, Dr. of Physico-Mathematical Sciences.

Among the apparatus, set up on the space station "Electron -2" are two magnetometers, by means of which the investigation is being conducted of the Earth's magnetic field and of the outer radiation belt. These magnetometers in their technical capacity and construction are similar to those used previously on the first and second Soviet space rockets, but enable to measure magnetic fields with an accuracy, greater, than the previous one.

The station "Electron-2" is designed specially for the study of the outer radiation belt and is estimated for a long-term operation.

We hope to obtain data for clarifying question as to what happens to the outer radiation zone during the geomagnetic storms. Until quite recently the scientists assumed, that the geomagnetic storm is a period, when the Earth and its magnetic field are bombarded by a flux of solar corpuscles - electrons and ions.

The station "Electron-2" will permit to elucidate the time-behavior of the magnetosphere boundary, in particular to clarify, whether this boundary gets closer to Earth during the storms, as it is assumed, or not, and what is the amplitude of its oscillations in space.

We should pause on one more question. According to an agreement concluded between the Academy of Sciences USSR and NASA of USA on the peaceful investigation of the outer space the implementation in 1965 is envisaged of a universal magnetic survey by means of Earth satellites. Observations at "Electron-2" are the first test of studying magnetic field variations of the outer radiation zone with an object of estimating regularity of these variations during the future universal magnetic survey.

At present the obtainable data are being processed, and the results will be published in scientific articles.

"Pravda", 7 February 1964.

SPACE SYSTEM "ELECTRON"

N successes of Soviet science in the mastering of space;

Over a month has passed since the stations "Electron-1" and "Electron-2" were launched into the circumterraneous outer space. The main object in the launching of these space stations is the simultaneous study of the Earth's radiation belts.

Today we publish an article on the significance and construction of space system "Electron".

1. Radiation belts of the Earth:

Soviet science and technique has opened the way into outer space. Even the first flights of the satellites have produced a lot of useful information about the outer space, resulted in discovery of new, as yet unknown to science, phenomen of nature - radiation belts of the Earth.

Farther mastering of the outer space for practical needs of mankind, such as extra-longrange radio-communication and reliable timely weather forecast, creation of extraterrestrial space laboratories, requires detailed study of the outer space properties. Launching of communication satellites, equipped with a composite apparatus for retransmission of television signals, meteorological satellites with automatic devices for meteorological investigations require assured long-term performance of devices in conditions of space flight.

On 30th January 1964 a successful launching was accomplished in the Soviet Union of a space system consisting of two scientific stations - "Electron-1" and "Electron-2", placed into different orbits by a powerful carrier-rocket. The creation of such a system opens new possibilities in the investigation of circumterraneous outer space and is of primary significance for cosmic physics. By means of the scientific stations "Electron-1" and "Electron-2" a wide range is being conducted of measurements, needed for deeper understanding of physical processes, taking place in various regions of the circumterraneous space.

One of the main objects of the "Electron-1" and "Electron-2" is the study of inner and outer radiation belts of the Earth. The charged particles flux in the radiation belts is very great.

Energy of many particles in the radiation belts is so high, that they are capable of penetrating into the space-craft.

The radiative irradiation is not only dangerous to the health of astronauts during a long term travel in the radiation belts, but also results in the property changes of various material, used on space objects. It has been fixed at present that the silicon solar batteries, used on satellites and space rockets, reduce the amount of produced electric power during irradiation by particles of the Earth's radiation belts. With very high irradiation the solar batteries may fail altogether which is what has happened to some American satellites after sharp increase in the intensity of irradiation in the radiation belts as a result of nuclear explosion, carried out by USA on the 9th of July 1962 at a high altitude.

It is also known, that some transparent material loses its transparency under the effect of irradiation and becomes opaque, which is specially unpleasant in optical systems. Many organic substances, applied as a thin film for imparting to surfaces various properties, for instance, to clear the optics, disintegrate under the effect of irradiation.

The study of the behavior of various material in the outer space is the business of newborn science - cosmic material supervision.

To determine reliability of any material during the space flight requires knowledge of radiation dose, likely to be received by the given sample of material. To forecast the radiation does the scientists have to know the state of radiation belts not only today, but to able to forecast their state for tomorrow. This requires knowledge of the laws controlling radiation belts, to understand the nature of their coming into being and continuing.

At present satisfactory explanation was given of the nature of the inner radiation belt of the Earth, discovered by American scientists on "Explorer-1". The effect of cosmic rays causes disintegration of the nucleus of atoms in the composition of the Earth's atmosphere. During disintegration of the atomic nuclei their components - neutrons - scatter to all sides and some of them escape from the atmosphere. Life-time of neutrons is only 12 minutes. The decay of neutron produces charged particles - proton and electron. If decay of neutron occurred in the vicinity of the Earth, the proton and electron are captured by the Earth's magnetic field and begin moving along a spiral trajectories, travelling from the northern hemisphere into southern and back along the magnetic lines of force. Prior to its destruction the particle travels hundreds of millions of times from one hemisphere into another. Each trip lasts less than one second. This circumstance indicates, that the Earth's magnetic field builds a "trap" for the charged particles. In this trap may accumulate many particles, since at high altitudes above the Earth density of matter is very low and the particles, which move there very slow lose their energy. This hypothesis explains very well the experimental data on composition and energy spectrum of particles in the radiation belt. Moreover, from the comparison of theory with experiment it is possible to obtain information regarding the density of atmosphere at altitudes of over one thousand kilometres.

An entirely different picture is observed in the outer radiation field, discovered by Soviet scientists during the flight of the third artificial satellite. It may be taken for granted that the above analysed genesis mechanism of the internal belt cannot explain the existence of the outer belt. Therefore even now the outer radiation belt is a mystery. Apparently, in the vicinity of the Earth at distances of thousands and tens of thousands of kilometres operates the unique "cosmic accelerator" of particles. On basis of data, obtained as a result of the satellites flights, we know, which particles are mainly speeded up in this "accelerator". However, the arrangement of this "accelerator" is unknown.

When the Earth enters into corpuscular flux, erupted from the Sun, there are magnetic storms and polar lights. At the same time there are the most intense changes in the outer radiation belt. It means, that at this time operate "circumterraneous cosmic accelerator".

This is why for resolving the puzzle of circumterraneous outer space simultaneous investigation should be conducted within it of various physical phenomena. This requires construction of a space system, consisting of a number of satellites, conducting simultaneous measurements in various regions of radiation belts. The launching of"Electron-1" and "Electron-2" is the first step in this direction.

Explanation of the nature of the "circumterraneous cosmic accelerator" will make it possible to resolve the most important science problems, Even now the existence is known of "cosmic accelerators" of incomparably greater scale. During the so called flares on the Sun acts "cosmic accelerator", the force of which is thousand times that of the "circumterraneous accelerator". This solar accelerator produces particles with energy upto 10 billion electron volts. Billion times greater in dimension. "Acceleration", producing particles with energy upto a million billion electron volts, lies within our Galaxy. Finally, beyond the limits of our Galaxy there is existence of accelerators, generating particles of even greater energy.

In order to understand the chain of these absorbing problems of the creation of high-energy particles, making up the composition of cosmic rays, the beginning should be made from the most accessible region of the circumterraneous space.

2. Orbits of "Electron-1" and "Electron-2".

Orbits of space stations "Electron-1" and "Electron-2" were selected on the grounds of necessity for the simultaneous investigation of the upper atmospheric layers, radiation belts of the Earth and circumterraneous space.

Moreover a number of other factors were also taken into account - conditions of radio-communication during the transmission of information from the stations to ground points, the existence time of stations in the orbit, exposure of stations to the Sun.

As a result of analyzing a number of possible versions for the space system "Electron" the selection was of two elliptical orbits with high eccentricity. This type of orbits provide for scientific investigations within the whole required range of altitudes. The first orbit lies within the most interesting regions of the internal radiation belt, partially intersects the outer and encloses a region of space with irregular magnetic field, where the formation of unstable flux of particles causing polar lights takes place. The second orbit is partially in the inner belt, the most interesting regions of the outer radiation belt and intersects lying beyond the outer belt region with transient flux of low energy electrons, denoted in literature as the outermost belt of charged particles. Altitude at apogee for the first orbit was taken at 7000 km, which corresponds approximately to the outer limit of the internal radiation belt, and the altitude at apogee for the second orbit was chosen within the range of 65000-70000 km. Altitude at perigee for both the orbits were fixed in the range of 400-460 km.

Naturally, the focal axes of the space stations orbits (i.e. the lines, connecting perigee with apogee) were selected of different direction. For the low orbit the location of focal axis corresponds to condition of a more favorable position in regard to the internal radiation belt. For the high orbit the position of focal axis in the orbital plane is chosen with a view of obtaining maximum possible difference of altitudes in similar geographical latitudes during the flight on ascending and descending turns of the orbit, which is important from the viewpoint of scientific measurements during the investigations of the outer radiation belt. The dip to equator of both the orbits is about 61°. The extent of the dip influences variation of orbital parameters under the disturbing effect of the Moon and the Sun, and also due to the flatness of the Earth. With the chosen dip the perigee of the orbits will shift in time northward and, which specially important, the orbit of the space station "Electron-1" with this shifting of focal axis will pass during a year through the whole thickness of the inner radiation belt.

The orbital diagram of the "Electron" space system is shown in Fig. 14. Perigee position of the orbits in the northern hemisphere provides the most suitable conditions for radio-communication of space stations with receiving points on the ground.

Moreover, when the stations are in the region of perigee the volume of information is maximum, since in this region besides the investigation of radiation belts measurements are conducted in connection with the study of upper atmosphere.

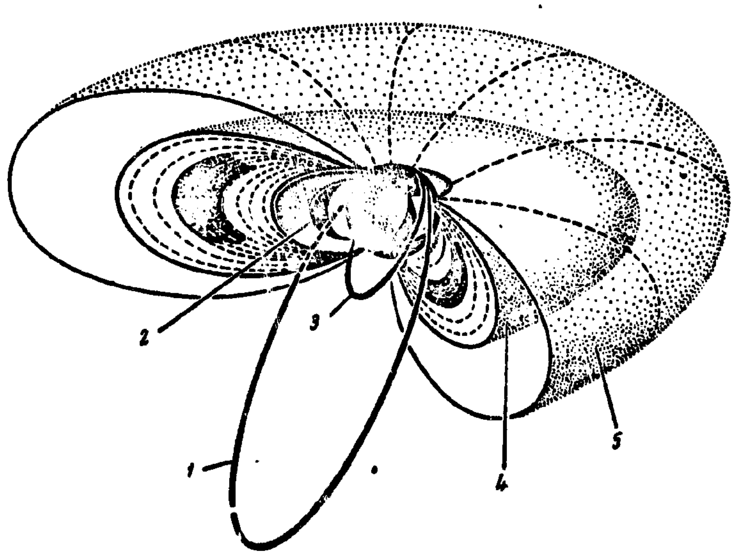


Fig. 14 - Orbital diagram of "Electron-1" and "Electron-2".

1- orbit of "Electron-2" station; 2- internal radiation belt; 3- orbit of "Electron-1"; 4- outer radiation belt; 5- the belt of low-energy charged particles.

It is a known fact, that Earth satellites, moving along the low orbits, have a limited time of existence due to their inhibition in the upper layers of atmosphere. With increasing altitude of orbit the existence of the satellite increases, since the inhibiting effect of the atmosphere decreases. For altitudes at perigee, corresponding to the orbits of the "Electron" system, the inhibiting effect of the atmosphere may be practically disregarded. However with increasing altitude at apogee of the orbit upto some tens of thousands of kilometres the motion of the satellite begins to be affected by new factors - the attracting forces of the Moon and the Sun. Calculations have shown, that with unsuitable combination of these forces the existence time of satellite on orbit with altitude at apogee 65000-70000 kilometres may well be just a few days.

In this connection detailed investigations were carried out of the motion of satellites in orbits with high apogee and the moments were determined of launching, which assured a long term existence for the space station "Electron-2" on the chosen highly elongated orbit.

The most expedient method of creating space system on the above orbits was the simultaneous placing of two space stations by one carrier-rocket.

Availability in the Soviet Union of powerful space rockets made it possible to resolve the problem precisely in this way. However the practical placing of two satellites on substantially differing orbits by means of one carrier was of considerable technical difficulties. To place "Electrone-1" and "Electron-2" into preset orbits required separation of the first of them on the active flight section of the last carrier stage during the operation of its motor. Seperation of the "Electron-1" and to be implemented in a way, so as not to cause disturbing moments, affecting operation of the control system of the last stage and the accuracy of placing "Electron-2". In the separation of "Electron-1" its entry had to be prevented into activity zone of the jet-powered last stage.

Both these difficulties were overcome by the application of a special reactive system, which assured separation of "Electron-1" from the last stage of the carrier-rocket at exactly present speed. The separation occurred without any disturbing effects on the further movement of the last stage. Besides the construction of "Electron-1" was devised in such a way, that the station would be most compact at the time of separation and would not have any highly projecting sections.

3. CONSTRUCTION OF SATELLITES AND THEIR APPARATUS:

"Electron-1" and "Electron-2" are automatic satellite-stations, developed for a composite study of circumterraneous space.

Figure 15 and 16 show the external view of satellite-stations "Electron-1" and "Electron-2".

Arranged on the outside of the stations are the solar batteries, antenna systems, part of devices for scientific investigations and data units of solar orientation. On the cylindrical section of the body are the rotating shutters of the thermo-regulating system. The special feature of the "Electron-1" are the collapsible antennas and panels of solar batteries, opening after the separation of the station from carrier-rocket on command from the time-programming device. This is to provide for the separation of the station on the active section of flight. At "Electron-2", the panels of solar systems are fixed rigidly.

In accordance with extensive program for the study of circumterraneous space the "Electron" stations contain various scientific devices for measuring at various points of the orbit. The results are recorded in memory devices, which accumulate scientific information and data on performance of the systems during one or several turns on the orbit (depending on the selected operation conditions of the memory).

During the communication, besides the transmission of memorised information, there is the direct telemetric transmission of a great number of parameters, recorded by the scientific apparatus, as well as data regarding performance of all the systems aboard the station. Operation control of devices is implemented in two ways - autonomously and by commands transmitted to the station along a special command radio-line from the ground stations.

The angular position of the "Electron" stations in space is determined by the solar orientation data units, the reading of which is recorded in the memory simultaneously with measuring results of scientific instruments.

Flight control of the space system "Electron" - measurements of orbital parameters, reception and recording of telemetric and scientific information, issue of commands for the cutin and cut-off of apparatus are implemented by the command and measuring complex on the ground.

Communication seances have confirmed, that the space system "Electron" is reliably controlled on commands from the Earth.

Let's stop now in more detail on the main problems, which should be resolved in the flights of "Electron-1" and "Electron-2". As mentioned above, the main object of the "Electron" space system is the study of inner and outer radiation belts of the Earth and the related physical phenomena. With this aim on board of both the satellites is set up identical apparatus for measuring electrons and protons of various energy. These measurements should enable to determine the composition of emissions in the radiation belts simultaneously at two points of the circumterraneous space.

The scientific station "Electron-1" flies around the Earth at comparatively low altitudes (below 7000 km). The study by means of this station is of the inner radiation belt of the Earth and the nearest to Earth "spurs" of the outer radiation belt. At th same time the station "Electron-2" cuts through the outer radiation belt and departs beyond its limits into interplanetary space, where the particles of radiation belts should not be present and the main type of radiation are the cosmic rays.

The presence of identical apparatus on both the satellites makes it possible to draw a picture of the spatial position of radiation belts and to tie the measurements of various satellites at different distances from the Earth. Some of the apparatus is inside an airtight container. These devices record particles of quite high energy, namely - electrons with energy of over 2 millions electron volts, protons with energy over 30 million electron volts and photons with energy over 50 kiloelectron volts.

Particles of lower energy cannot penetrate into the air-tight container. Devices for recording of these particles are set up on the outside of container. Radiation detectors are covered by the finest layers of substance. Their thickness is just a few thousandth fractions of a millimetr. These detectors are penetrated by electrons with energy over 30 kiloelectronvolts and protons with energy over million electronvolts.

For recording particles of even lower energy the use on "Electron-2" is of the so called spherical analyser. The path

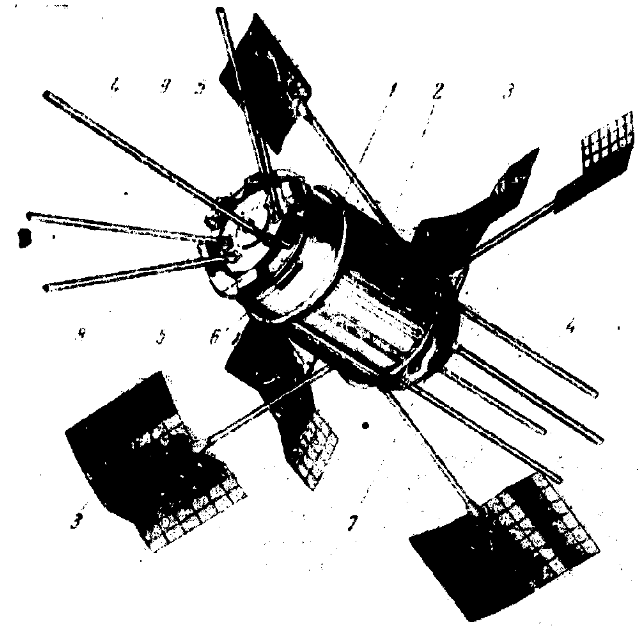


Fig. 13 - Space station "Electron-1".

1- air-tight container; 2- shutters of thermoregulating system; 3- solar batteries; 4- antennas; 5- micrometeorite detector; 6- device for recording corpuscular radiation; 7- mass-spectrometer; 8- proton detector; 9- device for studying energy spectrum of electrons in radiation belts.

of the particles arriving in this analyser is quite free of any obstacles. Deviating in electrostatic field, the particles move in a circle. During the flight, the electrical voltage, applied to the spherical analyser, is automatically switched-over, thereby capturing protons and electrons of various energy, starting from 100 electronvolts.

Particles of low energy are measured also by the "trap" of charged particles, similar to those, by means of which in flight of Soviet space rockets discovery was made of the "geocorona" of the earth and the outermost belt of charged particles, lying beyond the outer radiation belt and consisting of comparatively low-energy electrons. Multiple measurements within the "geocorona" and in the outer belt itself by means of detectors of low-energy particles should considerably increase the amount of information regarding these regions of the circumterraneous space.

On board the station "Electron-1" transmitter "Mayak", emitting coherent radio-waves is set up. By observing these waves by means of ground stations it is possible to follow the propagation of radio-waves and to determine concentration of electrons at high altitudes.

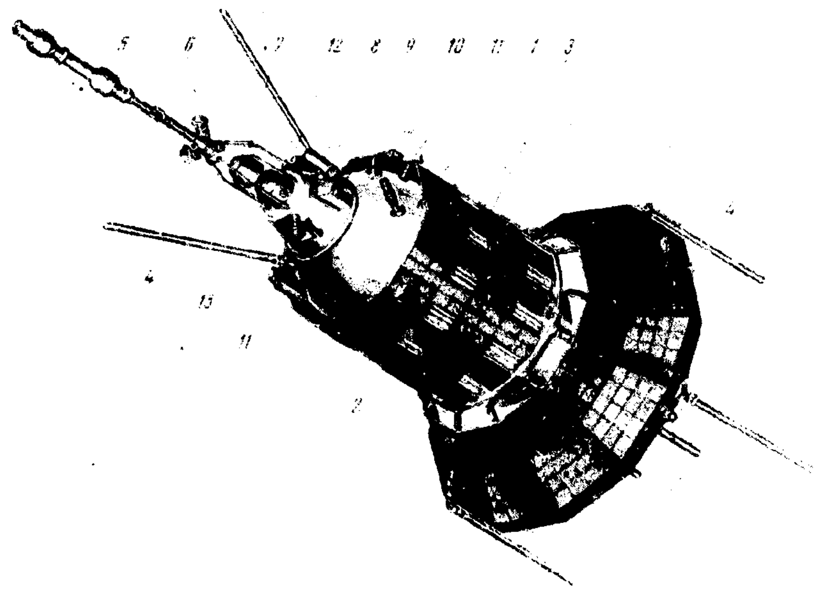


Fig. 16 - Space station "Electron-2".

1- air-tight body of the station; 2- shutters of thermo-regulating system; 3- solar batteries; 4- antennas; 5- magnetometer; 6- data units of solar orientation; 7- spherical analyser for energy spectrum study of low-energy particles; 8- device for the study of chemical composition of cosmic rays; 9- device for the energy spectrum study of electrons in radiation belts; 10- mass-spectrometer; 11- device for investigating X-ray radiation of the Sun; 12- detector of low-energy protons; 13- charged particles trap.

On "Electron-1" the low-energy particles are recorded by a special counter combined with accelerating tube. For the cathode protection of photoelectric multiplier from the light the crystal of the counte should be covered by some opaque material. No matter how fine is the foil, covering the crystal, it still prevents entry into the crystal of electrons with energy less than 10 kiloelectronvolts. The accelerating tube in front of the crystal fills-in this gap, imparting to slow electrons additional speed by bringing up their energy to 10 kiloelectrovolts. Thus, the device on "Electron-1" makes it possible to record electrons from the lowest energies (about 10 electronvolts) to some tens of thousands of electrovolts. This information should supplement the data obtained by means of the above devices on board of satellites. Thus, the extensive set of various devices enables to study in detail composition of radiations, to determine nature and energy spectrum of particles, composing radiation belts.

The motion of radiation belts particles is determined by the magnetic field of the Earth. Therefore the information regarding the radiation belts should be supplemented by data on magnetic fields. Moreover, motion of particle of the radiation belts may result in the generation of electric current, wh... in turn induces an additional magnetic field. To record magnetic fields, at the most remote from the Earth satellite "Electron-2" are two magnetometers, which measure magnitude and direction of the magnetic field's intensity. One magnetometer has lower sensitivity, but has the facility to measure a sufficiently high-intensity magnetic field of the Earth. The other magnetometer is designed for recording of weak magnetic fields, existing in the outer radiation belt and even at great distances beyond it.

Concentration of various energy charged particles in the radiation belts and the magnitude of the magnetic fields induced by these particles are closely interconnected. Simultaneous measuring of various particles and magnetic fields will provide a most important information about the radiation belts of the Earth.

It is quite obvious, that investigation of the composition of the Earth's upper atmosphere has a great value. In the present article we would like to emphasize the possible existing bond between the radiation belts of the Earth and the composition of the upper part of the Earth's atmosphere. Particles of radiation belts "travelling" from the northern hemisphere into the southern sometimes end their life below those regions, where exist the radiation belts. Under the effect of a number of factors, many of which are not yet discovered, particles of radiation belts get "spilled" out of them and bombard the upper atmospheric layers. Thus, the radiation belts affect the Earth's atmosphere. On the other hand, it is possible, that some of those particles, which after acceleration and escape beyond the atmosphere become particles of radiation belts, originate in the upper layers of the atmosphere. Set up on both the scientific stations "Electron-1" and "Electron-2" are mass-spectrometers, which enable to determine chemical composition of the upper atmospheric layers.

It is quite possible, that besides the elementary particles (electrons and protons) the finest dust particles, the so called micrometeorites of extremely small size, also revolve around the Earth. It was fixed by preceding tests in flights of Soviet and American satellites, the number of micrometeorites close to the Earth is greater than in the interplanetary space. This is, apparently, due to the fact, that close to Earth micrometeorites, arriving from the interplanetary space, are supplemented by meteorites, long-time revolving around the Earth. "Electron-1" contains micrometeorite detector. By means of it, it is possible to record the number of impacts on the path of the station's motion.

"Electron-1" also contains devices, recording X-rays of the Sun. High-intensity X-ray radiation is generated during a high-power blasts on the Sun, the so called "flares". Recording of X-rays makes it possible to determine the activity state of the Sun and to elucidate the connection of these phenomena with the state of radiation belts. The construction of automatic laboratory, flying far from the Earth, will make it possible to investigate radiations reaching us from the depths of the outer space.

The greater part of cosmic rays originate beyond our Solar system. The atmosphere and the megnetic field of Earth are a substantial obstacle in the way of these rays to our planet. The "Electron-2" moves far away from the Earth and escapes beyond its magnetic field. Therefore it contains devices for the recording of cosmic rays. Some of these devices permit not only to measure the general intensity of cosmic rays, but also to determine their chemical composition, i.e. to define, which atoms nuclei and in what quantity are present in the composition of cosmic radiation.

Even quite long ago people observed heavenly bodies very distant from us. This was possible due to the fact, that the human eye is capable of observing distant stars. The possibilities of modern astronomy have greatly increased, when besides the visible rays it was possible to observe also the invisible, radio-waves reaching us from the outer space. A new science has emerged - radioastronomy.

It is a known fact, that the Earth is surrounded by ionosphere, which reflects short, medium and long radio-waves. It is because of this property of ionosphere that the communication is easy between radio-stations of the different continents of the Earth. But the same property makes it impossible for radio-waves with wavelength over 100-150 metres to pass through to us from the outer space. They reach ionosphere and are reflected back into the space. Yet these waves carry a most valuable information regarding the distant regions of the Universe.

In order to record these radio-waves, it is necessary to escape beyond the Earth's ionosphere. The "Electron" satellites contain radio-receivers, which should make it possible to record the radio-waves with wavelength 200 and 400 metres coming from space. There is no doubt, that these radio-waves will provide us with most valuable information about the outer space.

It is over a month now, that the successful flight of "Electron-1" and "Electron-2" is continuing. By 12 o'clock March the 12th 1964 "Electron-1" has completed 357 revolutions around the Earth, and 155 radio-communications were held with the satellite. "Electron-2" has completed 44 revolutions and had 25 radio-communications.

The extensive material, obtained during the month's flying of "Electron" stations, pertains to period of the calm Sun. Further measurements by means of "Electron-2" and "Electron-1" will permit to study time variations of the circumterraneous space at various levels of the solar activity.

C.N.Vernov, Associate of the Academy of Sciences of USSR,
G.A.Skuridin,Dr. Physico-Mathematical Sciences,
Yu.I.Logachev,Master Physico-Mathematical Sciences.

"Pravda", 15 March, 1964.

TASS COMMUNIQUE ON THE LAUNCHING OF "ELECTRON-3" AND "ELECTRON-4"

In accordance with investigation program of the upper layers of the atmosphere and the outer space launching was carried out in the Soviet Union on 11th July 1964 of a space system, consisting of two scientific stations (Earth satellites) "Electron-3" and "Electron-4", placed into substantially different orbits by one powerful carrier-rocket.

The object of the launching is the continued composite investigation of the Earth's radiation belts, various radiations arriving from the depths of the outer space, magnetic field of Earth and physical conditions in the upper layers of the atmosphere.

The separation of "Electron-3" was carried out in the active section of flight with operating motor of the carrier-rocket's last stage, which thereafter continued its flight and after picking-up the required speed placed into preset orbit the space station "Electron-4".

According to tentative,data, the space stations were placed into orbits with the following parameters:

"Electron-3" - altitude at perigee 405 km, altitude at apogee 7040 km;

"Electron-4" - altitude at perigee 459 km, altitude at apogee 66,235 km.

Revolution periods of the stations are 2 hrs. 48 min. and 21 hr. 54 min. respectively.

The dip of the space stations orbits to equator is 60°52'.

Besides the devices for scientific investigations the stations have radio-transmitters "Signal" and "Mayak", operating on frequencies 19.943, 19.954, 20.005, 30.007 and 90.022 megacycles, and radio-telemetric systems for transmission to the Earth of the investigations results.

Radio-telemetric information, received from "Electron-3" and "Electron-4" indicates normal functioning of all the systems.

The coordination-computing center is processing the arriving information.

"Pravda", 12 July, 1964.

TASS COMMUNIQUE ON THE LAUNCHING OF SPACE STATION "PROTON-1"

In order to assure the implementation of the planned investigation program of the outer space, a new high-power carrier-rocket was constructed in the Soviet Union.

By means of this rocket scientific space station "Proton-1" with a set of measuring instruments was placed into circumterraneous orbit on 16 July 1965.

Total weight of the working load, placed into orbit (without the last stage of the carrier), is 12.2 tons.

The "Proton-1" station is equipped with special scientific apparatus for investigating cosmic particles of ultrahigh energy.

The space station "Proton-1" was placed into orbit with altitude at apogee 627 km and at perigee 190 km. Dip of orbit is 63.5°. Revolution period of the station around the Earth is 92.45 minutes.

Besides the scientific and measuring instruments the station has radio-transmitter, operating on frequency 19.910 megacycles.

Analysis of received telemetric information shows, that the apparatus on board space station "Proton-1"operates normally.

The coordination-computing center is conducting the processing of arriving information.

"Pravda", 17 July 1965.

SPACE STATION "PROTON-1"

After the launching of the first in the world artificial Earth satellite, which has opened the new era of space flights, the Soviet science and technique has attained considerable success in the investigation and mastering of the outer space.

Construction of high-power carrier-rockets has enabled the Soviet constructors and scientists to accomplish the first in the world manned space flight.

Further development of the rocket technique made it possible to construct heavy automatic stations, inhabited spacecrafts and to accomplish in them group flights with a man's exit into space. But the science sets new, progressively more composite problems of investigation and mastering of the outer space, requiring construction of heavier space-rocket systems with even higher energy power.

On 16 July 1965 in accordance with plan of space investigations a successful launching was carried out by means of a high-power carrier-rocket of the scientific space station "Proton-1" into circumterraneous orbit with altitude at apogee 627 km, at perigee 190 km and dip of orbit 63.5°.

The total weight of the working load placed into orbit - space station "Proton-1" and the set of measuring apparatus, - composes 12.2 tons.

Construction and successful production of the main systems and individual stages of the new carrier-rocket enabled to accomplish the placing into orbit of the complex scientific apparatus, included in the space station "Proton-1".

The perfection of the new space carrier-rocket is specified by many technical indices, including the considerable capacity of the main power units generating over 60 millions horse power.

Launching of the new carrier-rocket with the scientific space station "Proton-1" proves the beginning of a new era in the study and mastering of the outer space. It opens to science great possibilities in the investigation of circumterraneous and circumsolar space and of the depths of the Universe through spacecraft of great weight, which will enable to conduct extensive scientific investigations.

The world press highly acclaimed the merit of this new Soviet achievement in the mastering of the outer space.

Scientific program of space station "Proton-1" is dealing with a number of fundamental physics problems of ultrahigh-energy cosmic rays.

The apparatus set up on the station envisages:

-study of solar cosmic rays and their radiation danger;

-study of energy spectrum and chemical composition of particles of the primary cosmic rays in the energy range of upto 100,000 billion (10^{14}) electronvolts;

-study of the nuclear interaction of cosmic particles with ultrahigh energy upto 1000 billion (10^{12}) electronvolts;

-determination of absolute intensity and energy spectrum of Galaxy origin electrons;

-intensity and energy spectrum determination of Galaxy gamma-rays with energy over 50 millions electrovolts.

For over thirty years cosmic rays are being studied by physicists of many countries. These investigations resulted in discoveries, which revealed an immense diversity in the nature of elementary particles, out of which is built the substance of the material world surrounding us.

Discoveries, made in the study of cosmic rays, have laid the foundation of the new sphere of science - physics of elementary particles, studying the nature of these particles, their interconnections and conversions, seeking the most elementary "bricks" of material. By investigating interaction of high-energy particles with substance, physicists study the main properties of elementary particles - their mass, electric charge, forces active between particles their structural peculiarities. For progressively deeper penetration into the "interior" of elementary particles the physicists require particles of progressively higher energies.

In the flux of cosmic rays, arriving on Earth from the Galaxy depths, particles are present (protons and atomic neclei of elements) of most diverse energies; thousands, hundreds of thousands and even billions of billions of electronvolts. These particles are by many orders more energetic, than those obtainable in terrestrial conditions by means of the most powerful accelerators.

The primary cosmic rays of high and ultrahigh energies, by invading the atmosphere, collide with the nuclei of its atoms and, by using up their energy at high rate, get absorbed in the atmosphere. Therefore intensity of the particle of cosmic rays with high and ultrahigh energy is so low even at the height of the mountains, that they practically cannot be used for the exact quantitative measurements, which are necessary for resolving fundamental problems of the theory of elementary particles.

However, if the investigations are conducted beyond the limits of the atmosphere, where the intensity of ultrahigh energy particles is hundreds of thousands times greater, than at the sea level, then it becomes possible to study the behavior of particles with energy of thousands and tens of thousands of billions of electronvolts. Investigations beyond the Earth's atmosphere can be accomplished only be means of artificial Earth satellites. In this connection there is a possibility in future to resolve one of the fundamental problems - the search for elementary particles, in particulars, those forecasts by the theory of so called "kvars" (reactive kilovoltampere), i.e. particles with charge 1/3 and 2/3 of electron's electric charge.

For carrying out the above investigations the construction is required of apparatus, capable of automatic separation of particles according to their energies, to select from all the particles of cosmic rays only those with very high energies, to measure their energy, determine nature of the primary particles (separate protons from the heavier atomic nuclei, and for the heavy nuclei - to determine their belonging to one or another chemical element), to study characteristics of their interaction with the atomic nucleus of matter.

Until now the main obstacle for the use of apparatus, by means of which it would have been possible to resolve the above problems, was the non-availability of sufficiently powerful carrier-rockets, capable of placing the artificial satellites of a weight required for the resolution of this problem into an orbit around the Earth. Actually, for the study of particles with energy of the order of 10^{11}-10^{15} electronvolt the weight of satellite should be over ten tons.

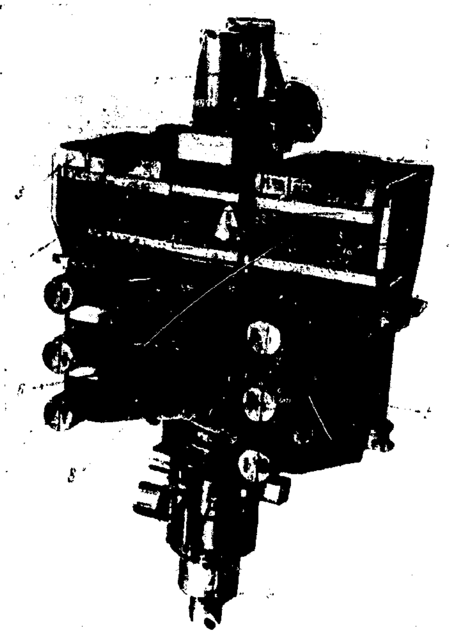


Fig. 17 - Scientific apparatus, set up on space station "Proton-1".

1- spectrometer of cosmic rays particles of moderate energy;
2- gamma-telescope; 3-8 complex of ionization colormiter;
9- device for recording high-energy electrons.

The present day space rocket technique has opened extensive possibilities for these investigations.

The construction of a new powerful carrier-rocket and space station "Proton-1" has enabled Soviet scientists to develop the required scientific apparatus.

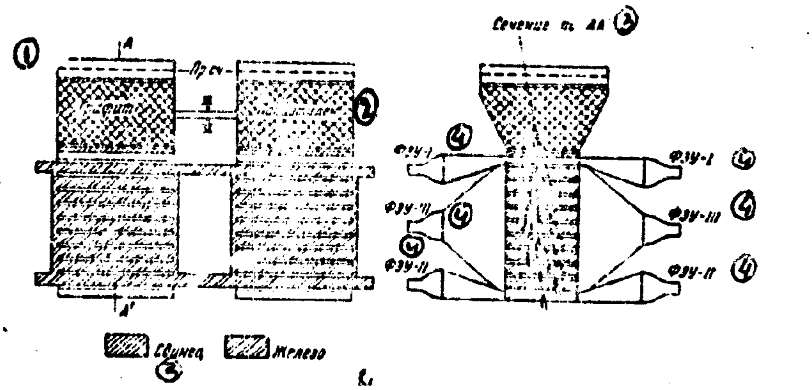
Fig. 17 shows photograph of the complex of scientific apparatus, set up on the space station "Proton."

This complex consists of ionization calorimeter with various measuring instruments 3-8, designed for energy measurements, determination of the nature of cosmic ray particles of high and ultrahigh energy and study of their interaction with matter; device for the study of high energy electrons 9; gamma-telescope for recording gamma-quantum of high energy 2; device for the study of chemical composition and energy spectrum of moderate-energy cosmic rays 1.

In order to study particles of cosmic rays with high and ultrahigh, energy, the ability is required to select from the whole diversity of particles, falling on device, those having high energy, i.e. primarily the energy of each individual particles has to be measured. With this object in view the Soviet physicists have developed an original method, embodied in a device, denoted as ionization calorimeter.

Fig. 18 shows schematic arrangement of ionization calorimeter and of the set of measuring apparatus for studying particles of high and ultrahigh energy.

The ionization calorimeter consists of a great number of steel plates, arranged between which are the scintillators of a special plastic. When high-energy particle falls onto ionization calorimeter it interacts with the atomic nuclei of iron atoms. As a result of collision secondary particles are produced, which in turn, colliding with iron atoms, give birth to particles of the next generation, etc. As a result the whole energy of the primary particle passes onto a great number of the secondary particles, which are then absorbed in the thick block of the calorimeter substance (Fig. 18 shows a sketch of the avalanche development of the secondary particles). The absorbtion of energy is accompanied by a light flare in the plastic scientillators, moreover the intensity of the flare is proportional to energy, absorbed in the ionization calorimeter, i.e. proportional to the energy of primary particle (the light flares are recorded by the photoelectric multipliers - PEM).



Fir: 18 - Diagram of the set of ionization calorimeter.
1 - graphite; 2 - pllyethylen; 3 - section;
4 - PEM-I, II, III; 5 - Lead; 6 - Iron.

To study the nature of cosmic ray particles - measuring of their electric charge - above the ionization calorimeter are arranged two special counters, in each of which the charge is measured independently. The use of the two counters should substantially increase the accurracy of measuring the charge will permit reliable separation of the primary high-energy protons from the heavier particles.

Under the counter is a carbon block on one half and polyethylen block on the other. These blocks are the substance, interaction with which of the particles with high energy will be the object of investigation. Under the blocks of carbon and polyethylene are the reaction detectors.

Polyethylene consists of iron and hydrogen atoms. Therefore in one half of the apparatus the reaction is studied of the ultrahigh energy particles with carbon atoms nuclei, and in the other - with nuclei of carbon and hydrogen atoms.

Results comparison of measurements implemented by both the halves permits to separate in pure form the reaction on nucleus of hydrogen atoms, i.e. protons.

Under the ionization calorimeter is the scintillation counter, which jointly with reaction detector separate particles, moving in a certain direction.

Moreover, set up on the space station "Proton-1" is the apparatus for studying electronic component of high-energy cosmic rays. The principle of ionization calorimeter is applied also for the measuring of the energy of electrons.

Among other problems, being resolved by the scientific apparatus of the space station "Proton-1", high significance has the gamma-quantum recording of the primary cosmic radiation, energy spectrum determination of the gamma-quantum in the energy region of 10^8-10^9 electronvolts, measuring of the energy spectrum and chemical composition of the primary cosmic rays of galactic origin, subjected to the effect of magnetic field, intensity variation study of cosmic rays, energy spectrum and chemical composition study of solar cosmic rays.

The scientific apparatus, constructed by Soviet scientists, is unique in its scale and specifications. For carrying out precise quantitative measurements it requires working in the actual conditions of space flight.

As a result of launching the first space station "Proton-1" the whole set of the scientific apparatus, construction of the station and its systems will be tested. At present the scientific apparatus is operating normally and has begun implementation of the planned program.

The space station "Proton-1" is a composite modern scientific laboratory. Besides the scientific apparatus it is equipped with instruments of telemetric and extratrajectory measurements, indication system of the station's position in space, programming devices, active damping system, control instruments of radio-command, power supply sources and thermoregulating system.

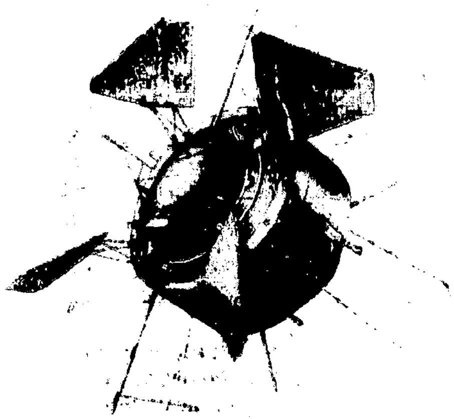


Fig. 19 - Space station "Proton-1".
1- panels of solar power unit; 2- air-tight body; 3- data units of the system indicating position of the station's axes in space; 4- external sheath; 5- antennas of telemetric, radio-command complex and of the complex of extratrajectory measurements; 6- chemical sources of current.

The internal air-tight body of "Proton-1" station protects it from the aerodynamic load and heat effect during its placing into orbit.

To prevent excessive heating and cooling during the orbital flight the station's body is covered on the outside by highly-effective thermoinsulation.

The required temperature is maintained inside the air-tight body and normal pressure has been provided for.

The air-tight body of the station is a cylinder with convex bottom. Inside it the rear and central portion is taken up by the scientific apparatus, position indicating system of the station, electro- and radio-equipment, telemetric instruments, and also units of thermo regulating units.

Attached on the air-tight body from outside are the panels of solar batteries and the mechanisms of their opening, also the sensitive data units of the position indicating system. Disposed on the rear bottom are the units of electro- and air-damping with cylinders of compressed gas, gas nozzles and control instruments. Also here is the external radiation heat-exchanger. On the station's body are the antenna systems of telemetric and radio-command complexes and the complex of extratrajectorial measurements.

Between the external reinforced shell and the station's body are the containers with chemical batteries.

The complex set of the scientific apparatus forces to resolve a serious problem - transmission to the Earth with high degree of accuracy of all the measured data. This is served by highly-informative telemetric apparatus on board.

The reliable and exact measurements of the orbital parameters are assured by the ground measuring complex and the special signal radio-equipment on board.

Operation of the scientific apparatus and all the systems of the station is controlled both by the programming device on board and by radio-commands from the Earth.

The indication system permits to determine the angular position of the station in space at every moment and, therefore fixes the direction of cosmic rays under investigation. The indication system includes combination of sensitive data units. The angular velocities of the station are measured several times a day by means of gyroscopes.

To calm the station after separation from the carrier-rocket and imparting some negligible angular velocity in respect of all three axes there is a damping system with gas nozzles, high-pressure cylinders and control apparatus. The station's rotation at low angular velocity assures normal operation of solar battiries, a more uniform temperature conditions of the station and the "required survey" for the scientific apparatus.

To provide temperature conditions required for the normal operation of apparatus, the station is equipped with thermo-regulation system.

The complex set of the board apparatus with continuous operation of the main systems required construction on the station of high power solar unit.

Solar batteries provide power supply to the apparatus on the sunny side of the orbit and recharging of the chemical buffer battery for power supply on the shady side of orbit, when the station is not lighted by the Sun.

Solar batteries are arranged on special panels, which prior to the station's placing into orbit are laid in the shape of truncated pyramid. In orbit the panels open out and are fixed by a special device, forming something like a four-cone screw.

Heavy artificial Earth satellites, similar to space station "Proton-1", equipped with apparatus of the type of ionization calorimeter, open out wide prospects for the study of a vast sphere of problems, which are long awaiting for their resolution. These include primarily precession measurements of the probability of collision of protons with protons at energies 10^{12}-10^{13} electronvolts, of protons with composite nuclei at energies 10^{12}-10^{14} electronvolts, study of the process of collision of ultrahigh energy particles (birth of secondary particles, their energy distribution and some other parameters). These investigations are necessary for penetration into the structure of elementary particles, study of the innermost secrets of the micro-world.

Similar investigations, conducted in terrestrial conditions by means of enormous accelerators, require construction of progressively more powerful and expensive accelerators. However, the accelerating technique places a natural limit on the attainable energies, approximately of 1000 billion electronvolts, and, apparently, during the next few years this type of accelerators will not be constructed. Investigation of the properties of elementary particles with ultrahigh energy by means of apparatus at "Proton-1" is an essentially new step in the investigation of cosmic rays.

Study by means of this apparatus of the chemical composition of cosmic rays, their distribution according to energies will enable to elucidate, how the "accelerators" which communicate to particles enormous ene gies, "work" in the interior of Glaxy. These investigations will bring us closer to understanding those processes, henomenal in scale, which control development of Galaxies and, perhaps, of the whole Universe.

"Pravda", 7 August 1965.

TASS COMMUNIQUE OF THE LAUNCHING OF SPACE STATION "PROTON-2".

In accordance with investigations program of the outer space launching was successfully accomplished in the Soviet union on 2 November 1965 by means of a high power carrier-rocket of a heavy scientific space station "Proton-2" and a set of measuring apparatus. The total weight of working load (without the last stage of the carrier) same as in the launching of space station "Proton-1" composes 12.2 tons and is the highest working load, placed so far into the circumterraneous orbit.

The space station "Proton-2" is placed into orbit with altitude at apogee 637 km and at perigee 191 km. The dip of orbit is 63°30', revolution period 92.6 minutes.

The "Proton-2" station is equipped by special scientific and measuring apparatus for the continued investigation of ultrahigh energy cosmic rays:

- study of solar cosmic rays and their radiation danger;
- energy spectrum and chemical composition study of cosmic rays in the interval of energies upto 100 thousand billion electronvolts;
- nuclear reaction study of cosmic particles with ultrahigh energy of upto 1000 billion electronvolts;

- absolute intensity and energy spectrum determination ofgalactic origin electrons;

- intensity and energy spectrum determination of Galaxy gamma-rays with energies over 50 million electronvolts.

Besides the scientific and measuring apparatus the station contains radio-transmitter, operating on frequency 19.545 megacycles.

Analysis of received telemetric information shows, that the apparatus on board the space station "Proton-2" operates normally.

Coordination-computing centre is conducting the processing of incoming information.

"Pravda", 3 November 1965.

TASS COMMUNIQUE ON THE LAUNCHING OF SPACE STATION "PROTON-3".

In accordance with the program of outer space investigations in the Soviet Union on the 6 July 1966 a successful launching was accomplished by means of a high-power carrier-rocket of a heavy space station "Proton-3" and a set of scientific and measuring instruments.

Space station "Proton-3" is placed into orbit with altitude at apogee 630 km and at perigee 190 km. The dip of orbit is 63.5 degrees. Revolution period 92.5 minutes. The "Proton-3" station is equipped with special scientific apparatus for continuing composite investigations of cosmic rays:

- study of solar cosmic rays;

- energy spectrum and chemical composition study of cosmic rays in the interval of energies upto 100 thousand billion electronvolts;

-nuclear reaction study of cosmic particles in the region of energies upto 1000 billions electron volts;

absolute intensity and energy spectrum determination of galactic electrons;

- the search in primary cosmic rays of particles with fractional electric charge.

Besides the scientific and measuring instruments, the space station contains radio-transmitter, operating on frequency 19.545 megacycles.

The analysis of received telemetric information shows, the apparatus on board space station "Proton-3" functions normally.

The coordination and computing center is carrying on the processing of incoming data.

"Pravda", 7 July 1966.

SOVIET UNIQUE EXPERIMENT "PROTON".

B.P. Konstantinov, Vice-President of the Academy of Sciences USSR has stated in regard to the recently accomplished in USSR successful launching of a heavy scientific space station "Proton-3".

With the launching of "Proton-3" the implementation continues of the program of studying cosmic rays, begun by the launching of scientific stations "Proton-1" and "Proton-2". One of the very important questions is the investigation of spectra and charge compsotion of high and ultrahigh energy particles and the study of conformity in their reaction with nuclei . We must remind, that the question is of the energies of particles, unattainable for the presently active and planned accelerators.

Tentative results were obtained on "Proton-1" of the effective cross-section of protons reaction with nuclei vs. energy. Measurements, conducted in the range of energies from 10 to 1000 milliards of electronvolts, have shown, that the reaction cross-section increases with the rise of protons energy, probably, by tens of percents.

Since this result with reliable confirmation will be of very high value for the further development of the theory of elementary particles, the same experiment is being repeated on "Proton-3" in better conditions and with better statistics.

On "Proton-1" for the first time has been measured directly the energy spectrum of the cosmic rays primary particles upto energies of 100,000 billions of electron-volts; unexpected results were obtained of the anomalously high intensity of electron flows with energies of hundreds of millions of electronvolts in proximity of theEarth.

Apparatus, set up on "Proton-1", made it possible to begin the study of the composiion of the primary cosmic rays within the sphere of very heavy atomic nuclei. It is interesting to mention, that prior to the launching of space station "Proton-1" by joint endeavours of many Soviet and foreign scientists the recording was made in the primary cosmic rays of just a few nuclei with charge of about 40 units. One flight of "Proton-1" has permitted to widen out appreciably our information on the fraction of nuclei with charges 40 and 50 in cosmic rays.

The launching of "Proton-2" had primary object to check and confirm those new and largely unexpected results obtained on "Proton-1". The amount of scientific information obtain-ed on "Proton-2" exceeds hundreds of times that obtained on "Proton-1".

Space station "Proton-3" is in principle a space scientific laboratory. The weight of the station is over twelve tons.

The two main objects of the scientific station "Proton-3" is the continuation of investigations begun on "Proton-1" and "Proton-2" with the setting up of a number of check tests, and carrying out of new investigations on particles with fractional charge.

The present-day theory indicates the possible existence of fundamental elementary particles, out of which all the highly-reacting particles are made up. One of the types of these fundamental particles has a fractional electric charge.

Only the experiment can answer the question whether such particles are existent in nature. If they do exist, they should originate in the particle collision of cosmic rays of ultrahigh energy with atoms of interstellar matter. Therefore their discovery is possible in the composition of the primary cosmic rays.

Set up on "Proton-3" is a new composite scientific apparatus for the search in the primary cosmic rays of elementary particles, the so called reactive kilovolt-amperes.

Moreover, on "Proton-3" the effective area of the apparatus for the study of superheavy nuclei in the composition of cosmic rays is enlarged almost ten times.

By launching of the scientific space stations series "Proton" new possibilities have been created for investigation of high and ultrahigh energy particles in cosmic rays. These investigations have already produced scientific results, which will help to develop our concepts in a number of spheres of physics and astrophysics.

On basis of the carried out investigations it is possible now to outline the way of their future development. It may be expected, that by means of the heavier space stations physical laboratories will be constructed beyond the atmosphere, which will enable us to study the finest processes, taking place in the collision of particles with enormous energies, and the gigantic processes will be studied within the depths of the Universe.

"Krasnaya Zvezda", 10 July 1966. (TASS)

TASS COMMUNIQUE ON THE LAUNCHING OF "COSMOS-1".

16 March 1962, the Soviet Union has carried out the next launching of the artificial Earth satellite.

According to tentative calculations the satellite came out into orbit with perigee 217 km and apogee 980 km. Period of the satellite's revolution is 96.35 minutes. Orbital inclination is 49°.

On board the satellite is scientific apparatus, radio-telemetric system, radio-transmitter, operating on frequencies 20/003 and 90.018 megacydles.

Observations of the satellite and reception of telemetric data is carried on by ground points of command and measuring complex, located in the territory of the Soviety Union.

On 16 March the satellite will pass above the following towns: New-York at 19 hrs. 46 min. Addis Ababa at 20 hrs. 12 min. Wellington at 20 hrs. 50 min., Los-Angeles at 21 hrs. 18 min., Ottawa at 21 hrs. 27 min., Melbourne at 22 hrs. 26 min.

The launching of the artificial Earth satellite is the continuation of the program for investigation of the upper atmospheric layers and outer space, for the implementation of which in 1962 a series of launching will be carried out from various cosmodromes of the Soviet Union of Artificial Earth satellites.

The scientific program of these investigations envisages:

- concentration study of charged particles in ionosphere with the object of investigating propagation of radio-waves;
- study of corposcular flux and low energy particles;
- energy composition study of the Earth's radiation belts for estimation of radiation danger during long-term space flights;
- primary composition and intensity variation study of cosmic rays;
- study of the Earth's magnetic field;
- study of the meteoric matter effect on construction details of space objects;
- distribution and formation study of clouds in the Earth's atmosphere.

Moreover, many construction details of the cosmic vehicle will be worked out.

Separate communiques will be published on the launching of this series of satellites.

As a result of accomplishing the marked program Soviet scientists will obtain new possibilities for investigating physics of the upper layers of the atmosphere and the outer space.

"Pravda", 17 March, 1962.

HUNDRED SPACE-PROBES.

Over three and a half years ago, on the 16 of March 1962, Soviet artificial satellite "Kosmos-1" was placed into orbit around the Earth, which laid the foundation for the extensive investigation program of circumterraneous cosmic space.

During the last few years in connection with considerable frontal expansion of theoretical and experimental work, steady development of rocket techniques and improved methods of investigations our concepts regarding the cosmic processes have become enriched to a considerable extent. Various grandiose phenomena of nature, such as solar activity(for instance, chromospheric flares), ionospheric and magnetic disturbances, polar lights and many others, have ceased to appear isolated from each other. Moreover, they could,obviously, be un erstood only by studying the interdependence of these phenomena. It is precisely this problem being pursued by many investigations, which are being conducted by Soviet scientists on "Kosmos-1".

Now, when the launching has been completed of one hundredth "Kosmos", a considerable amount of information has been obtained both on scientific and applied problems, connected, in particular, with construction details improvement of the space vehicles, working of the orientation systems, providing of reliable protection against the dangers of radiation, conditions investigation of the entry into atmosphere and landing in a preset area. Among the results of scientific investigations, data on radiations of inner and outer zone of radiation belt is of undubitable practical interest. Due to long-term measurements on "Kosmos" satellites radiation doses were determined inside the satellites and in the surrounding space at altitudes of their flight. This radiation was investigated against the solar and geomagnetic disturbance. The obtained results have enabled to confirm the nature of recordable penetrating radiation. At the same time distribution and intensity were studied in detail of the charged particles in areas of the Southern Atlantics and the coast of Brazil, where anomalies of the geomagnetic field are evident.

Besides these data, significant for the checking of radiation environment in the nearest space, where passed the routes of our "Vostoks" and "Voskhods", was the consequence study of high-altitude thermonuclear blast, carried out by Americans on the 9 of July 1962. Powerful penetrating radiation of explosion products has considerably increased the irradiation dose (specially during the first day after the explosion), to which the space men would have been subjected to an altitude 200-300 km even behind the quite solid protection. As shown by the subsequent measurements on "Kosmos" satellites, the artificial radiation belt, formed after the explosion did not get "dispersed" for a long time at high altitudes, specially in the vicinity of equatorial plane.

Of highest interest to geophysicists are the flux investigations of low-energy electrons and ions. These radiations are not dangerous to space men, but they appreciably affect the basic processes in the upper atmosphere, such as polar lights, intensity variation of magnetic field, density and temperature rise of the atmosphere. The charged particles, generally denoted as "geoactive corpuscles" were investigated for quite some time by the instruments of "Kosmos" satellites. Discovery was made of "softer" particles - electrons with energies of some tens of electronvolts, formed in the ionization of the upper atmosphere by solar ultraviolet radiation. Distribution of these and higher energy electrons in relation to magnetic lines of force and their variations provide the grounds for assuming existence in the upper atmosphere of electric fields, which affect the dynamic processes in the Earth's magnetosphere and on the reaction of magnetosphere with "solar wind" - plasma flux continuously blasting it.

According to program of universal magnetic survey experimental data were obtained by measurements with a special construction device - proton magnetometer - regarding the intensity of geomagnetic field at altitudes of about 300 km from the Earth's surface. The investigations included also sources of the variable magnetic field and extent of their effect on the variations of the fields mean values in the vicinity of the Earth.

Regular background measurements of the primary cosmic rays and their intensity variations have enabled to follow some conformities, connected with solar and geophysical phenomena, and to obtain a definite information regarding the nature of high-energy particles and processes, occuring in the interplanetary space.

Considerable attention was paid to the study of terrestrial ionosphere and propagation conditions of radio waves. Concentration of electrons and its orbital variation were investigated by ground-stations recording of radio-signals from board transmitters "Mayak". Various large - and small - scale ionspheric nonuniformities were also investigated. The majority of these nonuniformities, connected, apparently, with ionospheric and magnetic disturbances, is on the level of the maximum electronic concentration layer in the ionsphere.

By means of various types of charged particles traps, concentration and temperature was measured of icns and electrons in ionosphere during a period, close to the minimum of 11-year cycle of solar activity. As a result a considerable change was discovered in altitude distribution of charged particles concentration in comparison to 1958, when the Sun was the most active.

Considerable changes during the period between the maximum and minimum of solar activity were noted also in the neutral atmosphere. According to data on the drag of "Kosmos" satellites due to aerodynamic resistance forces distribution was calculated of atmospheric density and variation estimated in the interval of altitudes from 170 to 300 km. This is of the highest value for predicting the existence time of satellites and specially of the piloted spaceships. Data were obtained also for higher altitudes. It is interesting, that density reduction in 1964 in comparison to 1958 at 300 km altutide was several times, and at 400-500 km - almost huhdred times.

Several "Kosmoses" were equipped for studying Earth reflected infrared and ultraviolet radiation, distribution of atmospheric radiation in altitude, etc. The results of these measurements are of high value for geophysics and at the same time provide important information for improving methods of meteorological forecasting and other objects. Of high practical value were also density measurements of the finest dust particles - micrometeors and their effect on the surface of solar batteries, optical instruments and construction details of satellites.

Naturally, it is practically impossible to name all the authors of these and others experiments not mentioned here. An extensive sphere of work was implemented by groups of specialists headed by Ya.L.Alpert, S.N.Vernov, K.I.Gringaus, Sh.Sh. Dolginov, V.I.Krasovskii, A.I. Lebedinskii, T.N.Nazarova, A.B. Severnyi and many others.

The success achieved by Soviet science in the study of cosmic space, is a great contribution into successful accomplishment of such achievements, as long-term flights of Soviet spaceship satellites "Vostok" and crews of cosmic ships "Voskhod", the use of artificial Earth satellites for radio-communications, transmission of television programs. Accumulation of experimental results of cosmic investigations places on the day's agenda questions of creating new modern theories for explaining the nature of diverse key processes,taking place in the Earth's atmosphere. The program of scientific investigations on Soviet artificial Earth satellites "Kosmos" is of primary significance for further study and practical use of the circumterraneous space for the good of mankind.

"Izvestiya", 18 December 1965. M. Marov, Master of Physico-Mathematical Sciences.

QUANTUM GENERATOR IN SPACE.

In 1954, as we know, Soviet scientists academicians N.G. Basov and A.M. Prokhorov have constructed the first quantum generator on a cluster of ammonia molecules, which radiated electromagnetic waves 1.25 cm in length. Simultaneously and independently similar generator was made by American investigators G. Caiger and H. Tawns. During the years since then a new trend was born in physics - quantum electronics, which has now become one of the leading branches of science.

About a year ago quantum device has practically came out into space. 26 November 1965 an artificial Earth satellite "Kosmos-97" was placed into orbit in the Soviet Union. On Board was a quantum generator, developed and constructed by a group of scientists and engineers under the supervision of Academician

N.G. Bosov and Prof. M.I. Borisenko. By now the specialists have totaled up the results of this most interesting experiment. "Pravda" correspondent has asked N.G.Basov to comment on these results. Here is what he said:

- Devices, based on the quantum principle, have a number of advantages over the ordinary generators of electromagnetic waves. The molecular oscillator is not of high power, but the stability (constancy) of its radiation frequency is very much higher than the indices of the best quartz (crystal) oscillators. This is what has specified their application in radio-technique as high-frequency generators, due to which the sensitivity of receiving apparatus has become many times higher.

The use of molecular oscillators in the board instruments of artificial Earth satellites will make it possible to establish communication with space vehicles, their control and transmission of telemetric information at enormous distances. Moreover, in this case the accuracy of the time-programming devices and trajectory control system will be considerably enhanced.

Simple in construction quantum oscillators on ammonia could be used ashigh-stability frequency generators on board. They are stable against vibrations, compact and long-lasting. The first test of quantum standard of frequcny(time) was set up on the satellite "Kosmos-97". The satellite was flying along an orbit with altitude at apogee 2160 km, and at perigee -221 km. One of the modified versions of "Kosmos" satellite with solar batteries was used for the test.

The molecular oscillator is fitted on the outside of the satellite and covered with a jacket. Through air-tight leads the oscillator is connected with the instruments inside the satellite.

The transmission of scientific tests results to Earth was by means of multichannel radio telemetering. For determination of coordinates and velocity vector the satellite is equipped with an orbital radio-control. This helped to determine the satellite's orbit and to predict its flight.

Operation of molecular oscillator was controlled by a special command radio-line from ground stations and independently - by means of time-programming device.

For the first time during the flight the molecular oscillator was tested in conditions of natural vaccum, the effect of weightlessness and of other factors of cosmic flight on the oscillator's performance was checked. Frequency comparison of molecular oscillator on board with the ground standards was conducted by means of a two-way radio-communication system. Data analysis of telemetry and frequency tests has enabled to make deductions required for further constructive development of quantum

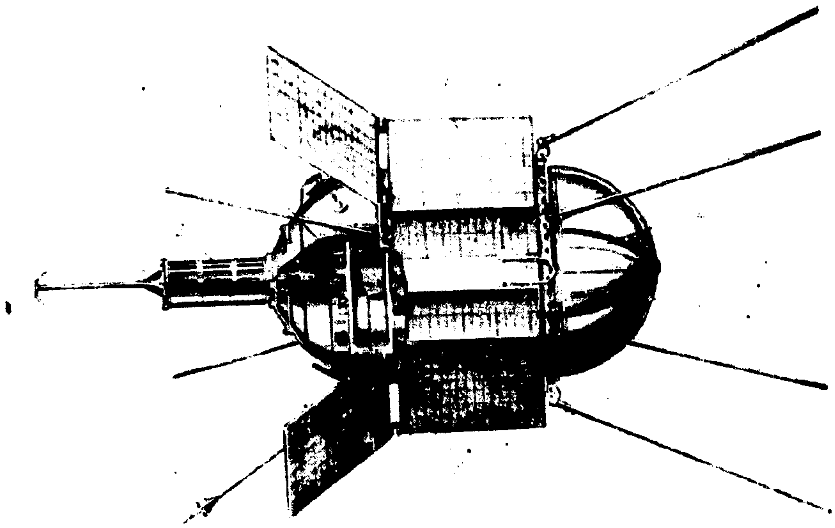


Fig. 20 - Artificial satellite "Kosmos-97".

10 scientific instruments compartment; 2- molecular oscillator; 3- solar battery; 4- buffer batteries block; 5- thermoregulation system; 6- servosystem block; 7- position transducer of satellite.

frequency standards on board with an object of constructing commercial samples of devices for widespread application.

"Pravda", 1 November 1966.

BIOLOGICAL ORBITING LABORATORY:

Increased duration of a man's flights into cosmic space and the rising difficulties of the set problems require preliminary intensive physiological investigations in conditions of the actual space flight. These investigations are directed to study the functional condition of a live organism. The highest value in these investigations is attached to the study of effect on living organism of factors, connected with the absence of terrestrial gravitation, and also the effects of cosmic radiation. These investigations should result in construction of systems and means, enhancing the stability of organism in conditions of cosmic flight.

Resolution of this problem is bound with penetration into finer working mechanisms of various physiological systems and requires application of composite methods of investigation, which could be carried out only on animals due to the following.:

- possibility of using composite methods (implantation of probes into the heart, into individual sections of vascular channel, withdrawal of blood in a sufficient quantity for carrying out of various biochemical investigations, implanting of electrodes into cerebral formations, etc.), which would enable to resolve the main questions of cosmic physiology;

- possibility of approving new systems and means, which would enhance the stability of organism to adverse effect of factors in cosmic flight;

- possibility of conducting biological recconnaissance of the future routes of cosmic flights;

- possibility of conducting investigations on cellular level (microscopy, enabling to determine fine structural changes in cellular formations).

On general recognition of Soviet and foreign investigators, the most defined changes, marked in the living organism in test conditions, will be in the activity of cardio-vascular system, which is largely responsible for the vitality of organism.

Hence the great interest of scientists to the working of the heart and of the whole circulation system in such unusual conditions is not just casual. The medico-biological test, which is being conducted on the specialized Earth satellite "Kosmos-110", is dealing with further intense study of this question.

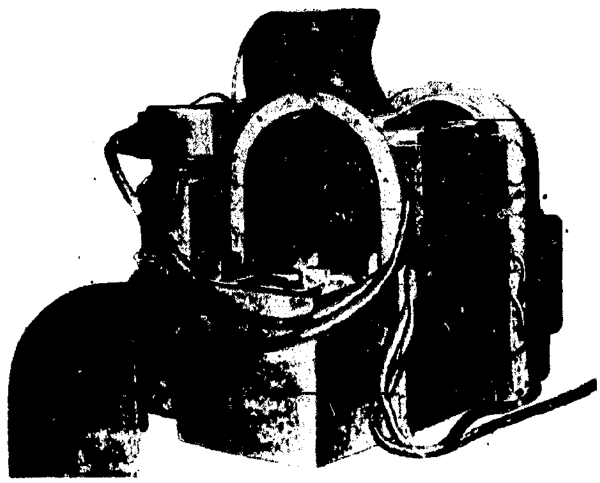


Fig. 21 - The outside view of the main animal's cabin.

The study in the present test is of one of the most important problems of cosmic physiology - the state of neuro-reflex regulation of cardio-vascular system. The following set of investigations is being implemented with this object:

- gauging of arterial pressure by means of a probe, implanted in the arterial canal of the animal; the same probe is used for administering pharmacological preparations, which permit to estimate the functional state of reflex regulation of the blood-circulation system;

- recording of the biocurrents of the heart by means of implanted electrodes;

- recording of a pulse curve from the carotid artery, brought out into a skin flap;

-recording of seismocardiogram and respiration.

Moreover, electrodes are implanted into peripheral nerves (sinus nerve), which provides the possibility to estimate the activity of the cerebral central formations, controlling the vascular tonus.

Two separate cabins are fitted on the artificial satellite "Kosmos-110" for the test animals - dogs Veterok and Ugolek. The chief test animal is Veterok, the second animal is for testing. The cabin of the chief animal, besides the systems and units, present in the second cabin, has a pharmacological container, vessels for keeping pharmacological preparations. Mounted on the same cabin is an air system, operating on compressed gas and serving both the cabins for supply of food and pharmacological means from corresponding vessels.

The outside view of the chief animal's cabin is shown in Fig.21.

The dog could adopt different positions in container. It is wearing a special corsetsuite for fixing it in the cabin and for attachment of various data units and communications, serving for scientific investigations and feeding(Fig. 22). The clearly visible in Fig. 21 the transparent hood with air-intake permits visual observation of the dog.

The diagram of the cabin is illustrated in Fig. 23. The air-tight container 1 of the animal is made of aluminium alloy and attached are the food container 2 and pharmacological container 3, also made of light alloys. The transparent bell 4 is made of organic glass. On top of container 1 is a block of physiological data units 5. Under the dog's stomach on the floor of container 1 is a collector of fluid waste 6, and behind the dog - collector of solid waste 7. Under the floor of container 1 is an air-system with cylinder of compressed gas 8. In a separate compartment 9 are the ventilators, filters and some other units and devices of the life-protecting system of the animal.

The food container 2 is meant for the storing of food supply for the whole flight and its feeding to the dog along the food line 10. In container 2 are elastic vessels, in each of which is stored food supply; the vessels are connected to the common container and food line 10. Pipes connecting vessels with container have shutters, which are opened by the actuator mechanism on command of the programming device. The feeding from the vessels is along the pipe 11.

The animals are fed by paste-like food, placed in portions in plastic containers, whence it is squeezed by pneumatic devices directly into the animal's stomach. The command for feeding are given from the command device according to program, fixed on earth and corrected, when necessary during the flight.

The feeding of medico-biological preparations from the pharmacological container 3 is along the hose 12 on command of the programing device. The preparations are fed by pressure of compressed gas, conveyed into container 3 from the air system along the pipe 11.

Fig.22: "Kosmos-110" has the following systems on board:
1) Conditioning and regeneration of air in the animals cabins;
2) Ventilation of cabins;
3) Disposal of solid and fluid waste;
4) Animals feeding.

5) administration of pharmacological preparations;

6) control and regulation;

7) telemetry.

The conditioned air is fed inside the animal's container through air-intake 13 of the transparent bell 4.

Ventilator 14, activated by electric motor, sucks the air out from container through collector of solid waste 7 and filters 15, which serve to clean the air from drop moisture and harmful admixtures. Rarefaction caused by the ventilator in animal's container provides for the arrival of fresh air in container through the air-intake 13. In order to increase the reliable working of system, special electronic unit 16 cuts in a duplicating ventilator 17 in the case if ventilator 14 should stop. Since in conditions of weightlessness suspended solid and fluid particles may accumulate in the air of the animal's container, special programming device cuts-in for half a minute every two hours of the flight an additional high-power ventilator 18 for their elimination.

In the control and regulation system the use is made of electronic command programming devices for giving the required signals to actuators, sensitive elements for recording parameters in systems and actuators of electric, pneumatic and mechanical type.

Signals of physiological data units 19, mounted on the corset-suites of animals, and transducers of various parameters in systems, and also signals for the feeding and implementation of various commands are transmitted to the ground coordination and computing center, which processes this information, by means of radio telemetric system.

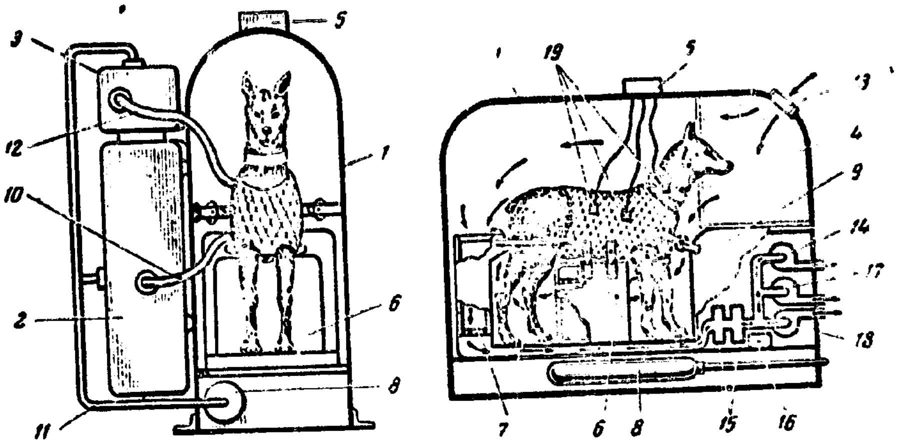


Fig. 23 - Diagram of the cabin.

1- the animal's container; 2- food container; 3- pharmacological container; 4- transparent bell; 5- block of physiological data units; 6- collector of fluid waste; 7- collector of solid waste; 8- cylinder of compressed gas; 9- separate compartment with ventilators, filters and some other units and devices of the animal's life protecting system; 10- food conductor; 11- pipe; 12- hose; 13- air-intake; 14- ventilator; 15- filter; 16- electronic device; 17- dublicating ventilator; 18- high-power ventilator; 19- physiological data unit.

The following is being carried out on the artificial satellite "Kosmos-110":

- administration of pharmacological preparations, individually affecting sensitive cells (chemoreceptors), located in the carotid zone;

- electric stimulation of sinus nerve, conducting impulsation from the carotid zone;

- pressing of carotid artery, brought out into skin flap;

- gauging of arterial pressure.

From the reaction of arterial pressure it is possible to judge regarding changes in the functional state of the most powerful zone, responsible for the regulation of vascular tonus.

From the level of blood pressure estimation is made of the reflex activity, which depends mainly on the work of the central formation of cerebrum.

Reflex activity is being estimated, which depends mainly on condition of mechanical receptors of vascular canal)formations, perceiving mechanical changes in the vascular wall).

The information is transmitted along the radio-telemetric channels of communication to the Earth, which makes it possible to assure quick medical checking of the animals condition.

In today's experiment the ship's orbit is for the first time chosen with an estimate of its being for a long time in zones with higher radiation (protons of the Earth's radiation belts).

In this connection it seemed necessary to carry out along these routes a set of investigation on radio-biology, protection and dosimetry of cosmic radiation. the main objects of these investigations are:

- radio-sensitivity study of various biological objects and its variation under the effect of cosmic flight factors;

- investigation and checking of methods for estimating protection of cosmic ships, and also of billogical objects from cosmic radiation;

- study of the distribution of doses and composition of cosmic radiation in the cabin of a satellite;

- testing dosage of radiation effect on dogs and other bio-objects;

-testing of some types of biological dosimeters of cosmic radiation.

For investigations of radiation safety the most suitable bio-objects were chosen on the artificial Earth satellites "Kosmos-110" with pertinent instruments.

Besides the dogs, the following bio-objects are contained on board the satellite in special containers;

- various strains of yeast;
- samples of blood serum ;
- preparations of various proteins;
- some strains of chlorella;
- some strains of lysogenic bacteria.

For physical investigations containers were placed on board the satellite with integrating dosimeters and nuclear emulsions and blocks for determination of protection measures for biological objects from cosmic radiations. Attached to each dog are sets of individual dosimeters.

In conclusion it may be mentioned, that data, incoming at present along the telemetry channels, permit to assume, that the experiment is successful.

N.M. Sisakyan, V.N. Pravetskii,
B. B. Egorov. (TASS)

"Pravda", 1 March, 1966.

COSMIC ARROW:

On 4th October 1957, Soviet carrier-rocket has placed into orbit the first in history artificial Earth satellite. Since then the Soviet science has made an enormous step forward in the study of the Universe, and the greatest service in this belongs to research satellites of the "Kosmos" series. The number of their launching is over 150.

New achievements of the rocket technique have made it possible to use the artificial Earth satellites for resolving important problems of the National Economy. By means of the satellite "Kosmos-122" the implementation was not only of meteorological investigations, but information was also obtained, useful for a quoik forecasting. Now another meteorological satellite "Kosmos-144" assists scientists from the altitude of its orbit to forecast the weather more exactly.

The investigations of cosmic space are continuing. Today the Editor offers for the attention of Readers an article about one of the new explorers of the Universe - artificial satellite "Kosmos-149".

One of the objects of the scientific program of investigations, announced by TASS on the 16th of March 1962 and conducted by means of artificial Earth satellites of the series "Kosmos", is the study of the Earth's atmosphere properties throughout its thickness. The application for this of Earth satellites is specified by the global nature of the atmospheric processes. These investigations are bound both with the use of artificial Earth satellites for weather forecasting and with questions of a more general geophysical significance.

At present by means of meteorological satellites television images are being obtained of cloud systems and actinometric data on the radiation field of the Earth. Qualitative synoptic analysis of this information is successfully used by scientists in the composition of operative weather forecasting. However further development of cosmic meteorology requires expansion in the composition of information obtained through satellites. For instance, data are required on temperature, humidity, wind velocity and, hence, development of new methods and corresponding apparatus.

Some of these problems were being resoleved, in particular, on "Kosmos-149" launched on 21st March 1967 on to orbit with altitude at perigee 248 km and at apogee 297 km. Inclination of the orbital plane is $48^{o}24'$. The experiment was in the nature of exploration and was estimated for a short active existence of the satellite. The obtainable data were not used for an operative meteorological forecasting.

The scientific instruments on the satellite included, in particular, two multichannel photometers. They were scanning the earth - following its surface in two perpendicular directions. The photometers determined luminosity of the planet in narrow intervals of spectrum, including the absorption band of molecular oxygen in the visible region. Another device - radiometer - measured self-radiation of the earth in the so-called atmospheric window (section of infrared spectrum with wavelength from 8 to 12 microns, in which the radiation is practically unabsorbed by the water vapor, always present in the atmosphere). The original construction of this device enabled to obtain the accuracy in measuring " radiation " temperature of about one degree. Television system was also set up on the satellite, which played an auxiliary part.

In contrast to actinometric program of "Kosmos-122" and "Kosmos-144", which was directed mainly to obtaining of complete (integrated in spectrum) "drifting" radiation of the Earth, the investigation program on "Kosmos-149" envisaged radiation measuring in narrow sections of spectrum. These measurements permit to obtain exact information atmospheric composition and characteristics of terrestrial surface and cloudiness.

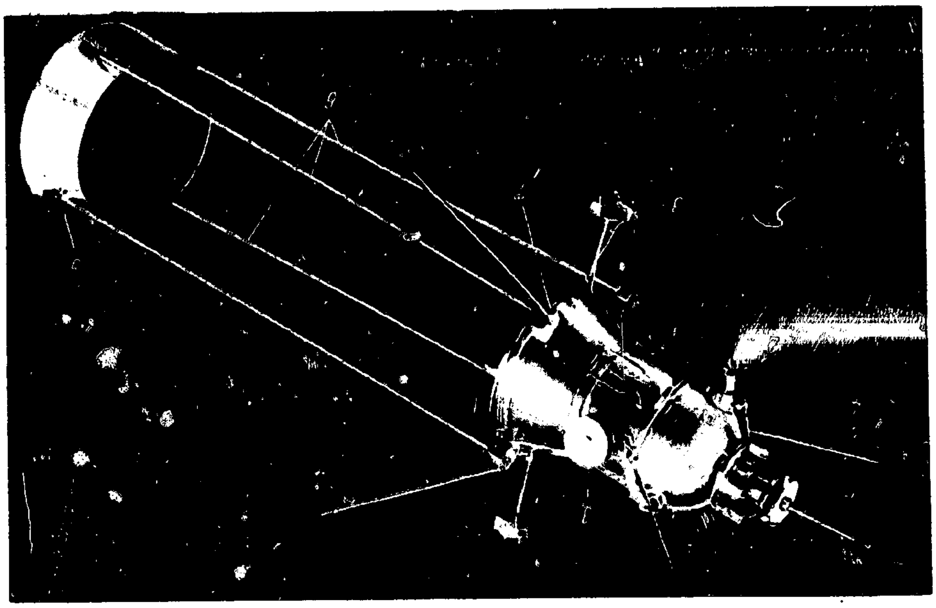


Fig. 24 - "Kosmos - 149".

1- body; 2- illuminator of television camera; 3- data units of automatics; 4- antennas; 5- aerodynamic stabilizer; 6- stabilizer rods; 7- advance mechanism of stabilizer.

The board systems and units of the satellite were operating according to a special program of the flight. Resutls of scientific tests and data on the operation of board systems were recorded by the memory and transmitted to Earth by multichannel radio-telemetric system with the passage of satellite above the USSR territory. Orbital parameters determination and prediction of the further flight of satellite were implemented by radio-control system. The operations of satellite were controlled from the Earth along a command radio line and independently by time-programing device.

The scientific instruments and service systems of satellite "Kosmos-149" were disposed in the air-tight body. Set up on the outside were the data units of the scientific instruments, antennas of the telemetric, command and television systems, illuminator of television camera. Maintained inside the satellite for normal performance of instruments is the pressure of inert gas, close to atmospheric, and a definite and quite stable temperature. On the rear hemisphere of the body are the shutters of thermoregulating system, on the front - actuators of gas-reactive system for preliminary calming of satellite.

Due to comparatively low latitude of flight it was possible to use on the satellite aeregyroscopic stabilization system, which assured a triaxial orientation in relation to vector of the oncoming flux and direction to the Earth's center with accuracy of five degrees. It is made up of a special aerodynamic stabilizer and gyrodamper.

Prior to the separation of satellite from the carrier-rocket the rods are folded and the aerodynamic stabilizer lies on the rear hemisphere of the satellite's body. After separation on command of the timing programer the rods are advanced by means of a special gear and the stabilizer gets set into working position at some distance from the body.

The designation of the aerodynamic stabilizer of the satellite is the same, as of the arrow's feathering. Stabilizer results in the appearance of reducing moment in pitching and wobble, which tend to combine the longitudinal axis of the satellite with velocity vector of the oncoming flux.

To assure stabilization in listing, i.e. elimination of turning around longitudinal axis, there is a pair of two-stage gyroscopes fitted on the satellite. Their total kinetic moment in normal stabilization is directed perpendicularly to orbital plane. The position of gyroscopes is arranged in a way, that with the deviation of satellite from the oriented position there is a reducing gyroscopic moment. Besides the stabilization in listing and yaw, gyroscopes also provide for damping, i.e. quenching of the satellite's self-oscillations.

Disturbances, which arise in the separation of satellite from the carrier-rocket, are reduced by means of short-lived action of the preliminary calming system. However the presence of this system on satellites with aerogyroscopic stabilization is, generally speaking, not necessary. The fact is, that the "cosmic arrow" has a single stable position of equilibrium, and the system of preliminary calming only reduces the time of the satellite's emergence into normal conditions of stabilization.

The aerogyroscopic stabilization system, used for the first time on "Kosmos-149", has a number of advantages over the widely known active systems of orientation, in which the application is of gas-jet engines or flywheels. Aerogyroscopic system does not need orientation data units and special actuators, which would have assured controlling moments. Insignificant amount of electric energy is consumed only for maintaining constant angular rotation velocity of the gyroscope rotors. The construction of aerogyroscopic system of stabilization is a new achievement of the Soviet cosmic technique.

As a result of "Kosmos-149" launching considerable information has been obtained about the thermal regime of the Earth's surface and of the clouds, quantitative characterstics of the cloud mantle, "tied" to television images, and also of the angular and spectral characteristics of our planet's luminosity, observable from space. Determination results of the atmosphere's physical parameters, obtained by means of the "cosmic arrow", are a new contribution of Soviet scientists into cosmic meteorology.

A. Obukhov, Associate of the Academy of Sciences USSR;
V.Mikhailov, Professor,
V. Sarychev master Physico-Mathematical Sciences,
L. Sokolov,Master Technical Sciences.

"Pravda", 12 April 1967.

"KOSMOS-166" IN SOLAR PATROL:

The ultraviolet and X-ray radiation of the Sun is of a great importance to us, the inhabitants of the Earth. Under the effect of short-wave solar radiation forms the Earth's ionosphere, which determines the conditions of radio-communication. These radiations affect the molecular composition and density of the upper atmospheric layers, hence also the heat balance of the lower layers.

Of not less importance are also various active processes in the solar atmosphere. The best known of these are the solar flares. During some of the flares there is a sudden intensification of X-ray radiation. And its "rigidity" in this case increases several thousand times. The fact is, that the these moments the Sun ejects very fast particles: hydrogen nuclei -protons - and nuclei of very heavy elements.

The "corpuscular flares", as they are called, have a deadly effect on living organisms and compose radiation danger for astronauts. The protection of crews by means of special absorbing screens is hardly feasible due to their heavy weight. Actually the body of space ship such, as for instance "Vostok" is in itself quite a strong protection, but does not resolve this problem. In spite of its resistance, irradiation of astronauts during the intensive solar flares may be upto several hundred rads. Whereas the admissible dose of radiation should not exceed 25 rads.

Upto now all flights of Soviet and American astronauts were in conditions, favorable in respect of radiation. This was due to the low-altitude orbits, which were under the protection of the earth's magnetic field, and the low activity of the sun. Finally, in the case of corpuscular flare danger (according to the data of operative checking of the solar activity) it was always possible to terminate the planned program of investigations ahead of schedule.

At present the sun enters into a new phase of high activity. It is shown in appearance of very frequent and powerful flares. In this connection it becomes specially important to develop methods and measures for ensuring safety of astronauts from the danger of radiation. For example, the construction is possible of a system, which would have provided for a composite use of active (magnetic, electrostatic) and passive (various screens) protection of compartments, arrangement of "radiation shelter", application of local protection for the vital organs of astronauts and the use of pharmaco-chemical preventive means.

Irrespective of this, it is important to determine the regularity in the appearance of radiation flares in order to predict them for a long term. The fact is, that the nature of the solar flares is upto now not fixed. Their physical entity, frequency, intensity and energy spectrum of emitted protons is hardly known. Radiational danger of flights is predicted at present from the observation data of ground observatories. But these provide information only of processes in the lower layers of solar atmosphere. There are grounds for assumption, that the X-ray and corpuscular flares are generated in the outer regions of the Sun. Therefore the study of the physical processes within the corona and the adjacent layers of the solar atmosphere is one of the basic problems of investigations on the Sun's physics, necessary for ensuring radiational safety of a man's flight into outer space.

One of the links in the extensive program of these investigations is the launching on the 16th of July 1967 of a special "solar" satellite "Kosmos-166". It was designed for investigation of the short-wave radiation of the Sun.

"Kosmos-166 " is a modification of the serial cosmic vehicle with orientation on the Sun of one of the satellite's axis. Motion control of the satellite's body in flight was by means of intertial masses - flywheels and gas-jet engines. This combined system is distinguished by being economical and by high accuracy of orientation throughout the whole active existence of the satellite.

Three times during each turn on command from the timing programer the orientation system changes into the so called scanning regime, in which the axis of the satellite intersects the solar disc in one direction at an angular velocity 0.04 degree per minute.

To obtain information from the orbital sections, where there is no communication with the ground stations, for instance in the southern hemisphere, memory of high capacity was used. The satellite's systems were energized from solar batteries.

The scientific apparatus of "Kosmos-166" consists of X-ray photometer, ultraviolet diffraction spectrometer and X-ray heliograph. Used as radiation receivers for the X-ray photometer were the Geiger counters of photons with oxygen-quenching mixture with beryllium or aluminium windows. The investigations were in the sections of spectrum with special interest for iluoidating the nature of solar flares. A check counter was used to determine the level of interference from the particles of radiation belts.

The X-ray heliograph consists of two similar blocks of data units, located outside the satellite, and electronics block inside the body. Each block of data units contains Geiger counters of X-ray radiation with vision fields limited by two slotted diaphragms, arranged crosswise. When the satellite's axis intersects the solar disc, its image is obtained in two perpendicular directions.

For tying the obtained recording to definite sections of the Sun, the use was made of optical data units, which fixed exactly the moments, when the edges of the solar disc were passing through the vision field of the counters.

The main detail of spectrometer is the concave refraction lattice. The radiations are recorded by means of open photoelectric multiplier.

The satellite "Kosmos-166" was implementing its objects for bout three months. During this time the Sun completed three total revolutions around its axis and its activity, according to data of ground stations, varied within a wide range. As a result an enormous amount of material was accumulated on statistics of X-ray flares and their connection with optical flares. This material will make it possible to follow in details the development dynamics of many flares, tc determine the flux and spectral composition of radiations, the dimensions and localization of regions, where the flares were originating.

Simultaneous recording by spectrometer of ionized helium lines provides invaluable information regarding the state of solar atmosphere under the flare.

Analysis of obtained data enables to determine physical conditions in the region of the flare and in adjacent active sections of corona (density of matter, effective temperature or energy of particles).

The results obtained by now are only of tentative nature: data processing still continues. However, even the examined material permit to draw some conclusions. Thus the rise time for the majority of flares is within the limits from 0.5 to 30 minutes. The drop of intensity is not always monotonous. In one case there was a "precursor" - a minor burst, preceeding he main phase of the flare. The possible existence of these " precursors" is indicated also by some data of indirect - ionsopheric - tests. The simultaneous appraisal of the radiation's spectral composition shows, that there is existence of relatively " cold" and "hotter " flares. Frequently there is a drop of temperature during their development.

As a rule, the X-ray flares originate above the active regions, observed by means of the ground optics. Dimensions of the flare's region are usually not above three angular minutes. It is extremely interesting, that in four cases the presence is defined in one flare of two centres, of approximately the same brightness. Distance between them composed about 6 angular minutes.

The obtained results confirm the earlier observations, implemented, mainly, on the satellite "Elektron-2". Then the presence was also fixed of a special class of X-ray flares, not associated with "optic" flares. These observations prove localization of a part of X-ray flares within the corona. The coronal origin of the X-ray flares makes it possible to assume, that they are closely bound with perturbations within the corona, resulting in corpuscular flares dangerous for space flights.

The corpuscular flux propagates slower than the X-ray radiation, due to the lower speed of particles and longer trajectory of their flight. Thus, in principle it seems possible, by recording X-ray flare, to warn the astronauts of the approaching radiation danger - corpuscular flux. This warning will enable the ship's crew to take the necessary protection measures.

Of course, development of the system for short warning of the radiation danger does not exclude the need for devising prediction methods of corpuscular flares. On the contrary, the required investigations of the Sun should be considerably widened. The special need for these investigations is specified also by the fact, that in the next few years, during which the man's flights inte space will be progressively on larger scale, the solar activity will be high and the cases of radiation danger quite frequent.

S. Mandel'shtam, V.Mikhailov - Professors;

Yu. Zaitsev - Engineer.

"Pravda", 2 October 1967.

SATELLITES OF "KOSMOS" SERIES,LAUNCHED IN USSR FROM 16 MARCH 1962 UPTO 1 OCTOBER 1967:

Name	Launching date	Altitude at perigee, km	Altitude at apogee, km	Orbital inclination degrees	Revolution period minutes	Radiotransmitter frequency megacycles	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-1"	1962, March 16	217	980	49	96,35	20,003 90,018	
"Kosmos-2"	1962, Apr. 6	213	1560	49	102,5	20,005 90,0225	
"Kosmos-3"	1962, Apr. 24	229	720	48,98	93,8		
"Kosmos-4"	1962, Apr. 26	298	330	65	90,6	19,995	30 April communique of successful landing of satellite.
"Kosmos-5"	1962, May. 28	203	1600	49.04	102,75	20,008	
"Kosmos-6"	1962, June 30	274	360	49	90,6	90,0233	
"Kosmos-7"	1962, July 28	210	369	65	90,1	19,994	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-8"	1962, Aug. 18	246	604	49	92,93	20,00504	
						90,02268	
"Kosmos-9"	1962, Sept. 27	301	353	65	90,9	19,994	
"Kosmos-10"	1962, Oct. 17	210	380	65	90,2	19,995	
"Kosmos-11"	1962, Oct. 20	245	921	49	96,1	20,0048	
						90,0216	
"Kosmos-12"	1962, Dec. 22	211	405	65	90,45	19,995	
"Kosmos-13"	1963, Mar. 21	205	337	64,97	89,77	19,995	
"Kosmos-14"	1963, Apr. 13	265	512	48,95	92,1	20,004	
"Kosmos-15"	1963, Apr. 22	173	371	65	89,77	19,996	
"Kosmos-16"	1963, April 28	207	401	65,01	90,4	19,996	
"Kosmos-17"	1963, May 22	260	788	49,02	94,82	20,005	
"Kosmos-18"	1963, May 24	209	301	65,01	89,44	19,996	
"Kosmos-19"	1963, Aug. 6	270	519	49	92,2	90,022	
"Kosmos-20"	1963, Oct. 18	206	311	65	89,55	19,995	
"Kosmos-21"	1963, Nov. 11	195	229	64,83	88,5		
"Kosmos-22"	1963, Nov. 16	205	394	64,93	90,3	19,995	
"Kosmos-23"	1963, Dec. 13	240	613	49	92,9	20,005	
"Kosmos-24"	1963, Dec. 19	211	408	65	90,5	19,995	
"Kosmos-24"	1964, Feb. 27	272	526	49	92,27	90,022	
"Kosmos-25"	1964, Mar. 18	271	403	49	91		
"Kosmos-26"	1964, Mar. 27	192	237	64,80	88,7	19,735	

contd....

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-27"	1964, Mar. 27	192	237	64,80	88,7	19,735	
"Kosmos-28"	1964, Apr. 4	209	395	65	90,38	19,996	
"Kosmos-29"	1964, Apr. 25	204	309	65,07	89,52	19,996	
"Kosmos-30"	1964, May 18	206,6	383,1	64,95	90,24	19,996	
"Kosmos-31"	1964, June 6	228	508	49	91,6	20,00487	
						30,00730	
						90,02191	
"Kosmos-32"	1964, June 10	209	333	51,28	89,78	19,996	
"Kosmos-33"	1964, June 23	209	293	65	89,38	19,995	
"Kosmos-34"	1964, July 1	205	360	64,97	90	19,995	
"Kosmos-35"	1964, July 15	217	268	51,30	89,2	19,996	
"Kosmos-36"	1964, July 30	259	503	49	91,9		
"Kosmos-37"	1964, Aug. 14	205	300	65	89,45	19,995	
"Kosmos-38"	1964, Aug. 18	210	876	56,17	95,22	20,034	Placing into orbit of three satellites by one carrier-rocket.
"Kosmos-39"	1964, Aug. 18	210	876	56,17	95,2	90,156	
"Kosmos-40"	1964, Aug. 18	210	876	56,17	95,22	20,084	
						90,378	
						19,800	
						89,102	
"Kosmos-41"	1964, Aug. 22	394	39855	64	715		Placing into orbit of three satellites by one carrier-rocket.
"Kosmos-42"	1964, Aug. 22	232	1009	49	97,8		
"Kosmos-43"	1964, Aug. 22	232	1009	49	97,8		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-44"	1964, Aug. 28	618	860	65	99,5	90,023	
"Kosmos-45"	1964, Sep. 13	206	327	64,90	89,69		
"Kosmos-46"	1964, Sep. 24	215	271	51,30	89,2	19,995	
"Kosmos-47"	1964, Oct. 6	177	413	64,77	90	19,994	
"Kosmos-48"	1964, Oct. 14	203	295	65,07	89,4	19,996	
"Kosmos-49"	1964, Oct. 24	260	490	49	91,83		
"Kosmos-50"	1964, Oct. 28	196	241	51,30	88,7	19,996	
"Kosmos-51"	1964, Dec. 10	264	554	48,8	92,5		
"Kosmos-52"	1965, Jan. 11	205	304	65	89,5	19,995	
"Kosmos-53"	1965, Jan, 30	227	1192	48,8	98,7	10,005 90,022	
"Kosmos-54"	1965, Feb. 21	279,7	1856	56,07	106,2	19,802	Placing into orbit of three satellites by one carrier-rocket.
"Kosmos-55"	1965, Feb. 21	279,7	1856	56,07	106,2	20,035	
"Kosmos-56"	1965, Feb. 21	279,7	1856	56,07	106,2	90,158	
"Kosmos-57"	1965, Feb. 22	175	512	64,77	91,1	19,997	
"Kosmos-58"	1965, Feb. 26	581	659	65	96,8	90,022	
"Kosmos-59"	1965, Mar. 7	209	339	65	89,7	19,996	
"Kosmos-60"	1965, Mar. 12	201	287	64,7	89,1		
"Kosmos-61"	1965, Mar. 15	273	1837	56	106	19,775	Placing into orbit of three satellites by one carrier-rocket.
"Kosmos-62"	1965, Mar. 15	273	1837	56	106	20,084	
"Kosmos-63"	1965, Mar. 15	273	1837	56	106	90,377	
"Kosmos-64"	1965, Mar. 25	206	271	65	89,2	19,996	
"Kosmos-65"	1965, Apr. 17	210	342	65	89,8	19,996	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-66"	1965, May 7	197	291	65	89,3	19,996	
"Kosmos-67"	1965, May 25	207	350	51,8	89,9	19,996	
"Kosmos-68"	1965, June 15	205	334	65	89,77	19,996	
"Kosmos-69"	1965, June 25	211	332	65	89,7	19,995	
"Kosmos-70"	1965, July 2	229	1154	48,8	98,3	20,005	
						90,022	
"Kosmos-71"	1965, July 16		550	56,1	95,5		
"Kosmos-72"	1965, July 16		550	56,1	95,5	20,084	Placing into orbit of five satellites accomplished by one carrier-rocket.
"Kosmos-73"	1965, July 16		550	56,1	95,5	90,378	
"Kosmos-74"	1965, July 16		550	56,1	95,5	19,8	
"Kosmos-75"	1965, July 16	550	550	56,1	95,5	89,1	
"Kosmos-76"	1965, July 23	261	530	48,8	92,2	--	
"Kosmos-77"	1965, Aug. 3	200	291	51,84	89,3	19,991	
"Kosmos-78"	1965, Aug. 14	206	329	69	89,8	19,996	
"Kosmos-79"	1965, Aug. 25	211	359	64,9	90	19,996	
"Kosmos-80"	1965, Sep. 3	[illegible]	1500	56,[illegible]	116,6		Placing into orbit of five satellites accomplished by one carrier-rocket.
"Kosmos-81"	1965, Sep. 3		1500	56	116,6		
"Kosmos-82"	1965, Sep. 3		1500	56	116,6		
"Kosmos-83"	1965, Sep. 3		1500	56	116,6		
"Kosmos-84"	1965, Sep. 3		1500	56	116,6		
"Kosmos-85"	1965, Sep. 9	212	319	65	89,6	19,995	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-86"	1965, Sep. 18	1380	1690	56	116,7		Placing into orbit of five satellites accomplished by one carrier-rocket.
"Kosmos-87"	1965, Sep. 18	1380	1690	56	116,7		
Kosmos- 88"	1965, Sep, 18	1380	1690	56	116,7		
"Kosmos-89"	1965, Sep. 18	1380	1690	56	116,7		
"Kosmos-90"	1965, Sep. 18	1380	1690	56	116,7		
"Kosmos-91"	1965, Sep. 23	212	342	65	89,8	19,995	
"Kosmos-92"	1965, Oct. 16	212	353	65	89,9	19,996	
"Kosmos-93"	1965, Oct. 19	220	522	48,40	91,7	20,005	
						30,0075	
						90,0225	
"Kosmos-94"	1965, Oct. 28	211	293	65	89,3	19,996	
"Kosmos-95"	1965, Nov. 4	207	521	48,40	91,7	20,005	
						30,0075	
						90,0225	
"Kosmos-96"	1965, Nov. 23	227	310	51,9	89,6	19,895	
						19,735	
"Kosmos-97"	1965, Nov. 26	220	2100	49	108,3		
"Kosmos-98"	1965, Nov. 27	216	570	65	92	19,996	
"Kosmos-99"	1965, Dec. 10	199	320	65	89,6	19,995	
"Kosmos-100"	1965, Dec. 17		650	65	97,7		
"Kosmos-101"	1965, Dec. 21	260	550	49	92,4		
"Kosmos-102"	1965, Dec. 28	218	278	65	89,24	19,735	
"Kosmos-103"	1965, Dec. 28		600	56	97		

6

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-104"	1965, Jan. 7	204	401	65	90,2	19,995	
"Kosmos-105"	1966, Jan. 22	204	324	65	89,7	19,995	
"Kosmos-106"	1966, Jan. 25	290	564	48,4	92,8		
"Kosmos-107"	1966, Feb. 10	204	322	65	89,7	19,995	
"Kosmos-108"	1966, Feb. 11	227	865	48,9	95,3		
"Kosmos-109"	1966, Feb. 19	209	309	65	89,5	19,995	
"Kosmos-110"	1966, Feb. 20	187	904	51,9	95,3	19,894	Satellite for biological investigations. On board are two dogs - Veterok and Ugolek.
"Kosmos-111"	1966, Mar. 1	191	226	51,85	88,6	19,365	
"Kosmos-112"	1966, Mar. 17	214	565	72	92,1	19,994	
"Kosmos-113"	1966, Mar. 21	327	327	65	89,6	19,996	
"Kosmos-114"	1966, Apr. 6	210	374	73	90,1	19,994	
"Kosmos-115"	1956, Apr. 20	190	294	65	89,3	19,995	
"Kosmos-116"	1966, Apr. 26	294	478	48,42	92		
"Kosmos-117"	1966, May 6	207	308	65	89,5	19,995	
"Kosmos-118"	1966, May 11		460	65	97,1		
"Kosmos-119"	1966, May 24	219	1305	48,5	99,8		
"Kosmos-120"	1966, June 8	200	300	51,8	89,4	19,995	
"Kosmos-121"	1966, June 17	210	354	72,9	89,9	19,995	
"Kosmos-122"	1966, June 25		625	65	97,1		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-123"	1966, July 8	263	529	48,8	92,2		
"Kosmos-124"	1966, July 14	208	303	51,8	89,4	19,995	
"Kosmos-125"	1966, July 20		250	65	89,5	19,735	
"Kosmos-126"	1966, July 28	212	359	51,8	90	19,995	
"Kosmos-127"	1966, Aug. 8	204	279	51,9	89,2	19,994	
"Kosmos-128"	1966, Aug. 27	212	364	65	90	19,995	
"Kosmos-129"	1966, Oct. 14	202	307	65	89,4	19,995	
"Kosmos-130"	1966, Oct. 20	211	340	65	89,8	19,995	
"Kosmos-131"	1966, Nov. 12	205	360	72,9	89,9	19,990	
"Kosmos-132"	1966, Nov. 19	207	280	65	89,3	19,995	
"Kosmos-133"	1966, Nov. 28	181	232	51,9	88,4	19,995	
"Kosmos-134"	1966, Dec. 3	214	319	65	89,6	19,995	
"Kosmos-135"	1966, Dec. 12	259	662	48,5	93,5		
"Kosmos-136"	1966, Dec. 19	198	305	64,6	89,4	19,995	
"Kosmos-137"	1966, Dec. 21	230	1720	48,8	104,3		
"Kosmos-138"	1967, Jan. 19	193	293	65	89,2	19,995	
"Kosmos-139"	1967, Jan. 25	144	210	50			
"Kosmos-140"	1967, Feb. 7	170	241	51,7	88,48	20,008	
"Kosmos-141"	1968, Feb. 8	210	345	72,9	89,9	19,995	
"Kosmos-142"	1967, Feb. 14	214	1362	48,4	100,3		
"Kosmos-143"	1967, Feb. 27	204	302	65	89,5	19,995	
"Kosmos-144"	1967, Feb. 28		625	81,2	96,92		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-145"	1967, Mar. 3	220	2135	48,4	108,6		
"Kosmos-146"	1967, Mar. 10	190	310	51,5	89,2		
"Kosmos-147"	1967, Mar. 13	198	317	65	89,5	19,995	
"Kosmos-148"	1967, Mar. 16	275	436	71	91,3		
"Kosmos-149"	1967, Mar. 21	248	297	48,4	89,8		
"Kosmos-150"	1967, Mar. 22	206	373	65,7	90,1	19,995	
"Kosmos-151"	1967, Mar. 24		630	56	97,1		
"Kosmos-152"	1967, Mar. 25	283	512	71	92,2		
"Kosmos-153"	1967, Apr. 4	202	291	64,6	89,3	19,995	
"Kosmos-154"	1967, Apr. 8	186	272	51,6	88,5		
"Kosmos-155"	1967, Apr. 12	203	286	51,8	89,2	19,995	
"Kosmos-156"	1967, Apr. 27		620	81,2	97		
"Kosmos-157"	1967, May 12	202	296	51,3	89,4	19,994	
"Kosmos-158"	1967, May 15	850	850	74,04	100,68		
"Kosmos-159"	1967, May 17	380	60600	51,83	19 33M		
"Kosmos-160"	1967, May 17	142	205	49,6			
"Kosmos-161"	1967, May 22	205	343	65,7	89,8	19,995	
"Kosmos-162"	1967, June 1	201	280	51,8	89,2	19,994	
"Kosmos-163"	1967, June 5	261	616	48,4	93,1		
"Kosmos-164"	1967, June 8	202	320	65,7	89,5		
"Kosmos-165"	1967, June 12	211	1542	81,9	102,1		
"Kosmos-166"	1967, June 16	283	578	48,4	92,9		
"Kosmos-167"	1967, June 17	201	286	51,8	89,2		

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
"Kosmos-168"	1967, July 4	199	268	51,8	89,1	19,995	
"Kosmos-169"	1967, July 17	144	208	50			
"Kosmos-170"	1967, July 31	145	208	50			
"Kosmos-171"	1967, Aug. 8	145	220	50			
"Kosmos-172"	1967, Aug. 9	202	301	51,8	89,4	19,995	
"Kosmos-173"	1967, Aug. 24	280	528	71	92,3		
"Kosmos-174"	1967, Aug. 31	500	39570	64,5	715		
"Kosmos-175"	1967, Sep. 11	210	386	72,9	92,2	19,995	
"Kosmos-176"	1967, Sep. 12	206	1581	81,9	102,5		
"Kosmos-177"	1967, Sep. 16	202	292	51.8	89,3	19,990	
"Kosmos-178"	1967, Sep. 19	145	205	50			
"Kosmos-179"	1967, Sep. 22	145	208	50			
"Kosmos-180"	1967, Sep. 26	212	370	72,9	90,1	19,995	

II. SATELLITES IN NATIONAL ECONOMY:

A. COMMUNICATION SATELLITES

TASS COMMUNIQUE ON THE LAUNCHING OF "MOLNIYA-1".

In accordance with the program for working out a system of long-distance radio-communication and television by means of artificial earth satellites active retranslators, the launching was implemented in the Soviet Union on the 23rd April 1965 into high altitude elliptical orbit of communication satellite "Molniya-1".

According to the data of computing center, the satellite is placed into orbit with altitude at apogee 39,380 km in the northern hemisphere and at perigee 497 km in the southern hemisphere. The revolution period is 11 hours 48 minutes. Orbital inclination 65°.

The retranslation apparatus for transmission of television programs and long distance radio-communication, as well as instruments of command and testing complex, orientation and orbital correction systems are boarded on the satellite.

The board apparatus is powered from solar batteries and chemical current sources.

The main object in the launching of communication satellite "Molniya-1" is the transmission of television programs and long distance two-sided multichannel telephone, photo-telegraphic and telegraphic communications.

The whole apparatus on board the satellite, as well as the ground radio complex function normally.

The first transmissions of television program between Moscow and Vladivostok were highly successful.

"Pravda", 24th April, 1965.

IN COSMOS - SOVIET COMMUNICATIONS SATELLITE:

Communications satellite "Molniya-1" was launched in the Soviet Union on 23rd April 1965. A multistage rocket has imparted to the satellite the required velocity and placed it into calculated elliptical orbit with apogee in the northern hemisphere.

The main object in the launching of "Molniya-1" is the transmission of television programs and long distance two-sided multichannel radio telephone, photo telegraphic and telegraphic communications.

What is the basic working principle of long distance radio communication system with the use of satellite "Molniya-1"?

The useful information, subject for transmission at long distance from one point to other in the form of telephone conversations, photo-telegraphic and telegraphic communications or television programs, is incoming to ground stations of space communications along the operative cable or radio-relay lines. The ground stations transmit this information by means of powerful radio-transmitters and highly effective antennas to communication satellite. The latter receives the signals, amplifies them and retranslates to ground stations. Those stations in turn transmit the received information from the satellite along the cable or radio-relay trunk lines to toll telephone stations, telegraphs or telecenters. For long distance radio communications the antennas should be sighted exactly on the translator - satellite. This is done by special devices.

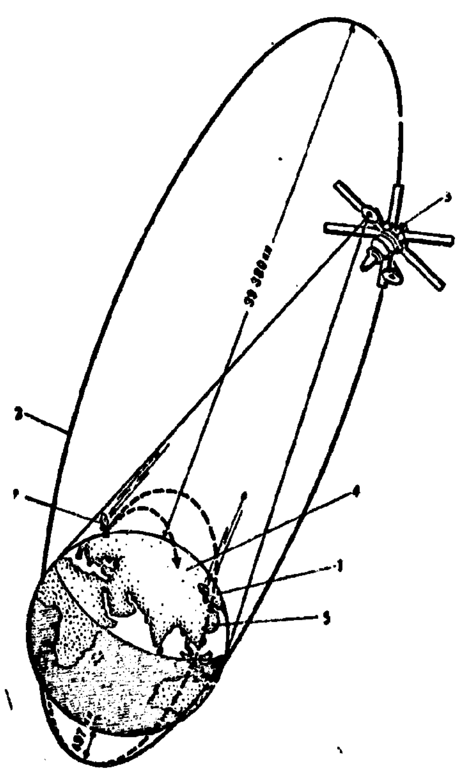


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Figure 1: Diagram of long distance radio communication with the use of satellite "Molniya-1".
1- Ground point of cosmic radio communication;
2- Elliptical orbit; 3- Communication satellite;
4- Radio visibility zone; 5- Intermediate orbit.

A few words about the orbit of communication satellite "Molniya-1". The orbit, just as the other parameters of the system has its own special features. The communication - satellite, as has been mentioned, was placed into elliptical orbit with apogee 39, 380 km, perigee 497 km and orbital inclination 65° (see figure 1). Revolution period of satellite is 11 hours 48 minutes and it passes above the Soviet Union territory during a few hours. This permits to assure long-term communication between Moscow and Vladivostok.

The board equipment of the satellite includes retranslator for transmission of television programs and long distance radio communication, as well as command and test complex, antenna feeders, satellite orientation and orbital correction systems. The directional diagram width of the satellite's parabolic antennas provides for radio communication throughout the whole territory of the Soviet Union. Radio units on board the satellite are powered by silicon solar cells and buffer batteries of chemical current sources. Every system of the satellite is automatically controlled.

Retranslator of the satellite "Molniya-1" operates on principle of the linear amplification of radio signals from the ground stations. Application of this type of retranslators makes it possible without delay simultaneously to receive signals from the earth and, having amplified the required level, to transmit them to earth without distortion.

The satellite's retranslator an command from the Earth enables to carry out the following types of radio-communication:

- reception and transmission through satellite of one television program;

- simultaneous radio-communication (reception and transmission) between ground stations of high number of two-sided telephone channels with possibility of additional densification by telegraph systems.

The equipment of the ground points in the system of long-distance radio-communication with the use of satellite "Molniya-1" consists of a composite set of large parabolic antennas with turning and programming devices and follow-up systems; command and testing apparatus and a set of communicating reception-transmitting radio-station.

For simultaneous transmission of image of signals and sound accompaniment a special apparatus was developed for combining these channels.

The distinctive feature of the television system is that continuous control is possible of the qualitative indices of television channel directly during the television transmission. This is attained by the introduction into transmitted image signals of special measuring impulses. Application of this type of control system enables to obtain continuously authentic information regarding the performace quality of the television channel.

In telephone conditions the system by means of a special apparatus provides for reception and transmission of a large number of two-sided telephone conversations.

The successful flight of the satellite "Molniya-1", normal function of the whole board apparatus and equipment of ground stations show, that these systems are highly promising and could be economically advantageous, specially for transmission of television to long distances and for communication with remote regions of the country.

upto now to meet the needs of national economy and population of our country the erections were of cable and radio-relay lines. A part of their function could be laid on the communication systems with the use of artificial earth satellites. However, this new method of radio-communication and the operative ground network should not be in opposition to each other. This new type of communication will be developed with an estimate of further improvement of the existing ground means. This will enable within a short period to bring broadcasting and television programs to all inhabited points of the vast territory of the Soviet Union. The majority of telecenter in future will be able to retranslate Moscow television program.

The successful launching of satellite "Molniya-1" which enables transmission of television, multichannel telephonic, phototelegraphy and telegraphic communication between Moscow and Vladivostok, bears witness to a new success of Soviet science and technique.

In our country everything is meant for the uplift of science and technique, mastering of outer space and using it for good of mankind.

N.Psurtsev, Minister of Communication, USSR.

"Pravda", April 25, 1965.

SATELLITES OF "MOLNIYA-1" SERIES LAUNCHED IN USSR

from 23 April 1965 upto 3 October 1967.

Name	Date of launching	Altitude at perigee, km	Altitude at apogee, km	Orbital inclination, degrees.	Revolution period, min.
"Molniya-1"	1965, Apr. 23	497	39 380	65	708
"Molniya-1"	1965, Oct. 14	500	40 000	65	719
"Molniya-1"	1966, Apr. 25	499	39 500	64.5	710
"Molniya-1"	1966, Oct. 20	485	39 700	64.9	713
"Molniya-1"	1967, May 25	460	39 810	64.8	715
"Molniya-1"	1967, Oct. 3	465	39 600	65	712

COMMUNICATION SATELLITE "MOLNIYA-1".

Successful development of cosmic technique has made it possible to put into communication service artificial Earth satellites.

To establish communication between ground points through satellites requires, that it should be simultaneously "visible" (we assume radio-visibility) from these points. During the periods of simultaneous "visibility" of satellite from ground points the communication becomes established, information is transmitted along the line Earth-satellite-Earth.

In accordance with the program of using satellites for building up a system of ultralong communication, "Molniya-1" satellite was placed into orbit in the Soviet Union on 23rd April, 1965. The orbit has altitude at apogee 39,380 km, altitude at perigee 497 km, orbital inclination 65 degrees, revolution period 11 hrs. 48 min. The apogee of the orbit is above the northern hemisphere, and perigee - above the southern.

Placing of the satellite into this orbit was carried out successively in two stages. Initially the satellite was placed into intermediate low orbit with the last stage of the carrier-rocket. Then the last stage of the carrier-rocket was launched above the southern hemisphere. The satellite was imparted an additional velocity and was placed into high altitude elliptical orbit with apogee above the northern hemisphere.

Completing every 24 hrs two turns around the earth, it passes at one turn over the territory of the Soviet Union, and at the other - over the territory of the Northern America. When flying above the territory of the Soviet Union, the satellite is within the zone of simultaneous "visibility" from Moscow and from Vladivostok. The duration of the satellite's flight within this zone, which determines the duration of communication, depends on position of the satellite relatively to these ground points. With certain orbital parameters the communication contact between Moscow and Vladivostok will be maximum.

With deviations of the satellite's orbital period from the calculated one the optimum reciprocal position of the satellite and the ground points will be disturbed, and this will result in the gradual decrease of communications period. Even with high precision of insertion into calculated orbit the orbital period of the satellite varies due to effect on its flight of the sun, the moon and the earth. In this connection it is essential to correct periodically the orbital period of the "Molniya-1" satellite. For this it is quite sufficient to vary the motion speed of the satellite at perige.

With high deviations of the orbital period from the calculated the correction is implemented by means of jet engine on the satellite. Such correction of the orbital period was carried out on the 2nd of May 1965. After this correction the orbital period became 12 hrs, altitude at perigee - 548 km, at apogee - 39,957 km. With this object the launching was conducted at perigee of correcting engine. Prior to this the satellite is fixed into position, at which the longitudinal axis of the engine is directed in line with the speed.

The satellite has a hermetically-sealed body of cylindrical shape with conical end plates. Set up on the outside are six panels of solar battery and two parabolic antennas. During orbital insertion the battery panels and the antenna are folded and open out automatically after the separation of satellite from the carrier-rocket.

Disposed at the bottom of the body are the correcting maneuvre engine and a system of microengines. At the other end are the orientation sensors to earth and sun.

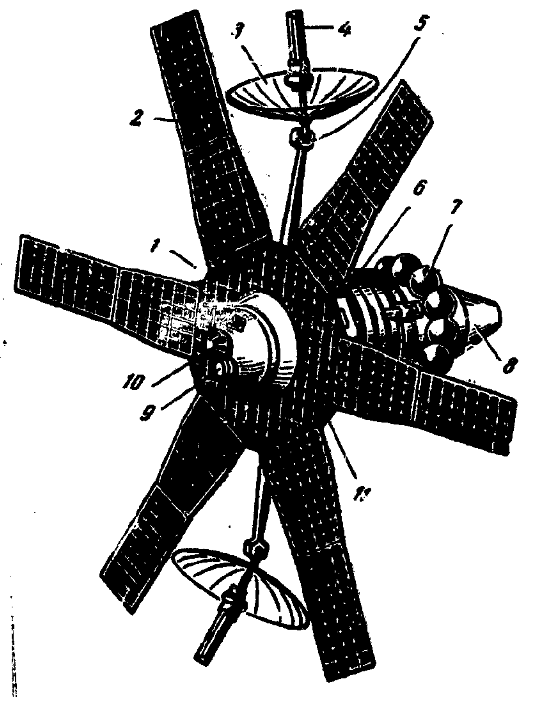

Fig: 2 - Communications satellite "Molniya-1".

1 - hermetic body; 2 - solar battery; 3 - pencil-beam antenna; 4 - orientation sensor(earth); 5 - antinna control device; 6 - radiator-cooler; 7 - reserve of working body for micro-correction; 8 - correcting maneuvre engine; 9 - orientation sensor for correction; 10 - orientation sensor (sun); 11 - heater-panel.

Attached to the body are the radiation surfaces of thermoregulating system - radiator-cooler of cylindrical shape and heater-panel in the shape of a flat ring. The construction of heater is utilized for disposing a portion of the solar battery cells.

Inside the body are the radio-electronic instruments and other equipment of the satellite. To ensure normal functioning of instruments, the required pressure and temperature are automatically maintained inside the body.

For energizing devices, set up in the satellite, there is a power system, consisting of solar batteries, chemical sources of current and automatic control of power supply.

During the whole flight the satellite is oriented by solar battery on the sun. Thereby the whole surface of the battery is illumined by the sun, which makes it possible to obtain energy from the whole area of the solar battery. Simultaneously with orientation of the satellite on the sun, one of the parabolic antennas during the communication period is directed to the earth, and tracks the earth by means of high-precision antenna control. The second antenna is in reserve. During tracking the antenna control is implemented by signals of the orientation sensor, fixed on this antenna.

For operating the reserve antenna the satellite should be turned at 180° about its longitudinal axis.

After the orientation of the antenna to the Earth the retranslation equipment is switched on. The transmitter emits signals by means of parabolic antenna. This antenna directs the radio-signals in a narrow beam directly to the earth. This directional radiation builds up a high level of signal on the earth's surface, which makes it possible to use at ground points antennas of comparatively small size.

By means of retranslation equipment it is possible to transmit through satellite television program or conduct a lot of telephone conversations, transmit still images, telegraph communications and other type of information.

For control the state and performance of all the satellite systems, it has set up a special telemetric equipment. By means of command control on baord and at the ground center the flight trajectory and parameters of satellite are determined with high accuracy. The same equipment issues and receives commands, transmitted from the earth to satellite for performance control of individual systems.

The equipment and systems of the satellite are controlled by the electronic programing computer on board according to programs, set by commands from the earth.

In its orbital flight the satellite "Molniya-1" flies for a considerable time in the radiations belts of the earth. With prolonged effect of radition on the equipment of satellite its individual details and systems may change their technical specifications or even cease operating. To study the effect of radiation belts on the systems of "Molniya-1", as well as for constant gauging of the radiation doses, received by the satellite in flight it has a special dosimetry probe set up on board.

From the 23rd of April of this year daily test are being conducted through communication satellite "Molniya-1" of the two-sided lines of space radio-communication between Moscow and Vladivostok. During the communication periods, the duration of each of which exceeds 9 hours, experiments are being conducted on transmission of television, telephone conversations, telegraphic and photo-telegraphic communications.

During the last few days experimental transmissions were conducted of color television. These tests were quite successful and produced very encouraging results. The tests have shown, that, using achievements of the Soviet and French scientists in the sphere of color television on base of SECUM system and its standard, it is possible to build up a most perfect system of color television, development and introduction of which is envisaged by an agreement between the USSR and French Governments.

It may be assumed, that in future operating systems of color television besides the ground radio means an extensive use will be made of the cosmic lines of communication and that the

"Molniya-1" satellites could be the basis for building-up these lines.

Further tests and working of the line of superdistant radio- and television communications by means of "Molniya-1" satellite are continuing.

Launching of the "Molniya-1" satellite and the build-up by its means of experimental line of superdistant radio- and television communications open new possibilities in the use of space technique for direct needs of the population and national economy of our country.

"Pravda", May 30, 1965.

TASS COMMUNIQUE.

COMMUNICATION SATELLITE "MOLNIYA-1" TRANSMITTS IMAGE OF THE EARTH.

The satellite "Molniya-1", launched on the 25 of April 1966, continues its flight in highly elliptical orbit, successfully assuring implementation of the planned program on further working and test operation of the system for distant two-sided television and telephone- telegraphic radio-communication.

In accordance with the program of scientific investigations experimental equipment is set up on the satellite, besides the communicating retranslation equipment, for observations of earth from space at great distance.

On the 18th of May 1966, an experimental observation of the earth was conducted by means of this equipment and a television image was obtained for the first time of the earth. The photos were taken from an altitude of 30-40 thous. k. The images were received by the stations of command control center, located in various areas of the USSR.

The television camera was directed on the earth by means of independent sighting system on board. During the photographing the objectives and light filters were changed and this made it possible to obtain the image of the earth in various scales and to observe the elements of terrestrial surfaces of various illuminance.

"Pravda" 19th May 1966.

B. METEOROLOGICAL SATELLITES:

SATELLITES AND WEATHER SERVICE:

The staff of the main Department of Hydrometeorological Service with the Council of Ministers of USSR jointly with representatives of research and industrial organizations have analyzed the launching results of some artificial earth satellites, carried out in accordance with the program of scientific investigations of cosmic space, anrounced by TASS cn 16th March 1962, which carried equipment for meteorological measurements, including satellite "Kosmos-122", placed into orbit on 25th June 1966.

Set up on the "Kosmo-122" are devices for televising the usual cover, cameras for the photographing of clouds in infrared rays on day and night sides of the earth and instruments for measuring radiation in the earth-atmosphere system.

Taking into account the results of working out the satellite systems on board and normal performance of the indicated meteorological instruments, it was recommended to begin the experimental use of these measurements in the operative weather service. The world's meteorological center in Moscow was directed to include the most interesting data, obtained in the above measurements, into information, meant for communication to weather service organizations in USSR and other countries. "Pravda", 18th August 1966.

METEOSTATION IN ORBIT:

The earth's atmosphere is a unique and composite natural medium. In order to know the state of the air envelope of our planet at each given moment and forecast its changes, the whole atmosphere should be watched by tens of thousands of eyes.

It is precisely for this that the enormous network of meteorological stations has been built up at every continent. But in spite of the efforts, which are applied for the observations of atmosphere in every country, this network still has big gaps. Vast ocean spaces still remain "uncovered". And even on land there are deserts, territories covered with virgin forest ice or high mountains, where it is difficult to maintain meteostations.

The need for information regarding the state of atmosphere is continuously increasing. The aircrafts surmount now gigantic routes without landing, such as Moscow-Havana, Moscow-Khabarovsk. In order to provide with weather forecasts these flights as well as to compile longterm weather forecast, it is necessary to know the state of atmosphere practically above the whole surface of the globe. These data could be quickly given only by the meteorological observations from satellite. Therefore the experiment, being conducted at present on the satellite "Kosmos-122" is very important.

"Kosmos-122" transmits to earth televised images of the clouds, covering greater part of the earth. The unique shape of the clouds, their position provide an experienced eye with a lot of information on the state of atmosphere. Out of the mosaic of separate photographs, made by the telecamera of the satellite during the flight around the globe and transmitted to reception points, charts are composed of the cloud cover. They permit the meteorologists to determine the nature of atmospheric motion, position of the fronts, dividing air masses of different properties, direction and velocity of air currents in the upper atmospheric layers.

However, the television cameras can observe clouds only on the illumined-day side of the earth. In order to determine disposition of the cloud-cover on the night - shadow side of the planet, the photographing should be in the infrared rays. True, the considerable part of them is absorbed by water vapor, always present in the atmosphere. But there are some sections of the infrared spectrum, in which the radiation is practically unabsorbed by the water vapor. On the satellite "Kosmos-122" is used one of these with wave length from 8 to 12 micrones. Through this unique "window" of the infrared radiation range it is possible to take photographs not only at night, but at day also. This permits to compare images of one and the same cloudiness, obained in visible and in infrared rays.

The third important part of the meteorological investigations on the "Kosmos-122" is the intensity measuring of radiation, outgoing from the earth. Solar rays, falling on the earth's surface, are the main source of energy and the cause of atmospheric motion. To analyse the atmospheric processes it is interesting and important to determine in which areas of the earth and how much energy was obtained by the earth's surface (and could be used for the heating of atmosphere), how much reflected into the outer space and how much heat energy is radiated by the heated earth surface and atmosphere into universe. These data on the main elements of radiation balance in the earth-atmosphere system are obtained by means of actinometric instruments, set up on the satellite "Kosmos-122".

The instruments measure intensity of radiations coming from below in three bands. Measurements in 0.3 - 3 microne band (visible light and near infrared region) permit to determine intensity of reflected radiation. The majority - about 70-80 % - are reflected by the clouds, about 30% by land and even less by sea surface. Radiation investigation in 8-12 micrones belt makes it possible to estimate the temperature of the visible from satellite surface of earth or of clouds. By the way, the temperature of the upper surface of the clouds characterizes also its altitude above the earth. Finally, radiation measurements in the 3-30 microne band make it possible to determine the total flux of the heat radiation from earth and atmosphere outgoing into universe.

If analysis of the cloudiness photographs, made in visible light or by means of infrared irradiation, can be implemented by a man by means of visual examination of photographs, the processing and analysis of radiation data are impossible without computers. Transmitted from satellite to reception points is an enormous amount of figures. Only the computer is capable of their quick processing. It should be taken into account, that during one orbital period of the satellit it has to be possible not only to receive, but also to decide and to present in a graphical form all data, transmitted ffom the outer space.

The Soviet scientists have developed methods for processing radiation measurements on computers. Signals, sent out by the satellite on radiation conditions, enter into computer

The latter compares radiation measurements with data on the satellite's trajectory, brings in the required corrections and issues information in the form of intensity distribution map of radiation throughout the globe.

In order to assure correct function of all meteorological instruments, the construction of the satellite has to conform to very rigid requirements. It should be constantly oriented to the earth surface. The objectives of its cameras should always face the earth. Swaying or rotation of the satellite about one of the axes is inadmissible. Maintenance of constant orientation and stabilization of the satellite in a certain position require special analog devices. All these devices, as well as memory, communication, etc., need considerable power. At "Kosmos-122" it is provided by the large solar batteries.

The construction of a complex of "cosmic" meteorological apparatus and all th required for its operation devices demanded great effort of constructors, engineers, scientists. The specifications of this apparatus conform in general to norms, worked out by the experts of the Universal Meteorological Organization.

At present the apparatus is being tested at some of the "Kosmos" series satellites. So far, from working conditions of the "Kosmos-122" satellite as a whole, the meteorological test data are gathered mainly on a part of its trajectory. However, the results could be used even now for operative service, training of weather beauro and for scientific investigations.

Therefore, the results of observations are transmitted into subsections of Hydrometeorological Service of USSR, as well as to Meteorological Services and Research Department of other countries.

The meteorological observations from satellites are being conducted also in the USA. The American satellites "Essa" transmit considerable amount of information regarding cloud cover of the planet. But these satellites do not have constant orientation on the Earth and do not provide information about the radiation and cloudiness on the night side of the Earth. Individual test photographs in infrared rays and radiation measurements were carried out in the USA, but so far these are not being used in the operative service.

Observations from satellites open out new, immense possibilities for the meteorological service and for the investigations of atmosphere. But at the same time the application of satellites presents unique and difficult problems.

Now, as well known, the Hydrometeorological Service of the USSR, just as of many other countries, is changing over to objective, numerical methods of forecasting the main elements of weather. Calculations from these methods are done on computers. Now these calculations have to include new characteristics, which hitherto were not estimated. Besides, the use of the surface layer temperature the estimates have to include temperature of the Earth surface, besides the vertical section of atmospheric temperature it is expedient to use data on radiation balance, etc,.

How can one imagine further development of observations from Earth satellites? Apparently, there will be systems of satellites, making it possible to compile maps of the atmospheric state once or twice in 24 hrs so that the composition of each map will consume several hours. This will require 2-3 constantly operating meteorological satellites.

Great interest is presented by observations from satellite, located at great altitude above the Earth surface, in a way, that its cameras would "see" at once a big area of the Earth. The first test on photographing the Earth from a distance of 20-40 thous. km were made on one of the Soviet communications satellites "Molniya".

In future it will be possible to obtain from satellites other data also, for instance about sediments, swell in the ocean. This will enable to improve considerably the marine forecasting and recommendation for selection of routes for long-distance vessels, etc.

Development of observations from satellites requires at the same time perfecting method of the obtained data analysis on computers. Hence the computers will have to find in the huge mass of receivable material information on the most important, and primarily on the most dangerous weather phenomena, and quickly issue data on hurricanes in the ocean, on storms, thunder storms. Only the total automation of all the stages of information processing, upto sketching of the cloudiness maps, temperature field of Earth surface, radiation field throughout the globe, will permit the appropriate use of the abundant material.

Will the ground meteorological stations be needed? Of course, although their working program may be considerably changed. It should be kept in view, that besides providing weather forecasts in considerable territories and at great distances the local needs must also be considered: primarily of the agricultural production, local airlines, etc. For this information is required of ground stations.

Meteorological observations from satellites open out extensive prospects for the weather service and for atmospheric investigations. The staff of the Soviet Hydrometeorological Serive are deeply grateful to our designers, engineers, scientists and workers, who have successfully resolved the main problems of constructing a composite complex of various devices for meteorological observations from satellites.

F.Fedorov,Academician,Chief of the
Hydrometeorological Serivice of
USSR.

"Izvestiya", 20 August 1966.

COSMIC METEOROLOGY

A tale of the artificial Earth satellite "Kosmos-144"

Five years ago, in accordance with program, announced by TASS on 16 March 1962. the first artificial Earth satellite of " "Kosmos" series was placed into orbit in our country. Since then the satellites of this series are being launched regularly. Their number is already close to hundred and fifty. The "Kosmos" satellites have greatly contributed to the study of the outer space, helped to uncover the pattern of a number of physical processes, taking place on the Sun, provided new important information regarding distant objects of the Universe.

But besides the great scientific significance, their launchingbegins to acquire an essential value in the national economy. Today we are publishing a tale of one of the satellites in the series "Kosmos-144" , meant for gathering meteorological information and transmitting it to the Earth.

Now a second Soviet meteosatellite "Kosmos-144" is flying around our planet. It was launched on 28 February into circular circumpolar orbit 625 km in altitude. It has, just as its predecessor "Kosmos-122" , scientific instruments, enabling the meteoservice to obtain very valuable data on the state of atmosphere above the extensive territories of the planet. The launching of satellite "Kosmos-144" is the continuation of work in the sphere of cosmic meteorology, being conducted by our country in accordance with the International agreement.

The alluring prospects of using artificial earth satellites in meteorology are convincingly verified in practice. Information regarding the state of atmospheric processes, transmited from cosmic orbits, are used for weather forecasts, for warning about the storms and typhoons. The value is specially high of the information, gathered by satellites from the vast areas of oceans, polar regions, desert and mountain areas.

The preceding meteosatellite "Kosmos-122" served continuously during four months and regularly provided an extensive meteorological information. Television, infrared and actinometric apparatus, as well as the control systems on board were functioning in space for several thousand hours. The analysis of satellite's performance has confirmed the correctness of calculations and technical decisions, taken during its planning and construction. During operation of satellite the experience was accumulated for operative processing and the use of information, obtained from the orbit, in the weather forecasting service. Application of the modern computers for processing the flow of information, arriving from the outer space, enabled the Hydrometeocenter of USSR to transmit the results of measurements to Meteorological Services of other countries.

Experience has shown, that the resolution adapted in our country on construction of meteorological satellite, assuring simultaneous measurement of a number of indices of the state of atmosphere, was correct and most effective. The accomplishment of this task demanded of the makers of the satellite and ground systems resolution of the new problems of cosmic technique, arising from the requirement of long-term performace of the systems and instruments in the orbit in the exactly present conditions, automation of processing and distribution of the obtained meteorological information.

The general view of "Kosmos-144" is shown in Fig. 3. Two panels of solar batteries, made-up of thousands of photocells provide the electric power. The main service systems are arranged in the upper compartment of the container, scientific instruments - in the lower compartment. The "wings" of the solar batteries open out after the separation of the satellite from the carrier-rocket. They are provided by an independent tracking system, assuring orientation of the plane of batteries perpendicularly to direction of solar rays, so as to provide for the maximum production of power. To prevent the overcharging of accumulators or inadmissible drop of voltage there is an automatic system for controlling power supply of the satellite.

For the majority of devices on board the satellite the electric energy is required as an alternate current in a wide band of frequencies - from tens to hundreds of cps. The direct current of the accumulator battery is converted into alternate by static semiconductor transformers, which are at the same time automatic regulators of voltage and alternate current frequency and assure synchronized operation of electrid motors, set up in various mechanisms on board the satellite.

During the flight the satellite is oriented exactly on Earth. One of its axes is directed to the center of the Earth, the second - along the trajectory and the third - perpendicularly to the orbital plane. The successful resolution of the problem in regard to exact spatial orientation of the long-term continuously-operating satellite by means of flywheel-electromotors is a remarkable achievement of the Soviet space technique. The exact orientation of the satellite had made it possible to apply the so called scanning infrared and actinometric apparatus, which follows from the orbit the processes in the Earth's atmosphere, continuously scanning it in transversal plane right to left and left to right. And due to the orbital flight of the satellite there is a scan band. Moreover, this orientation has considerably simplified processing of measuring results. The equipment on board the satellite includes, besides the orientation and power systems, a number of radio-electronic and electro-mechanical devices. They assure memorizing of measuring results and their transmission to the Earth; radio-observation of the satellite and parameters determination of its flight; present temperature; single time for tying measuring results to localities; control and regulation of the apparatus performance. The appratus complex of the satellite is controlled by automatic device on board, as well as on commands from the Earth.

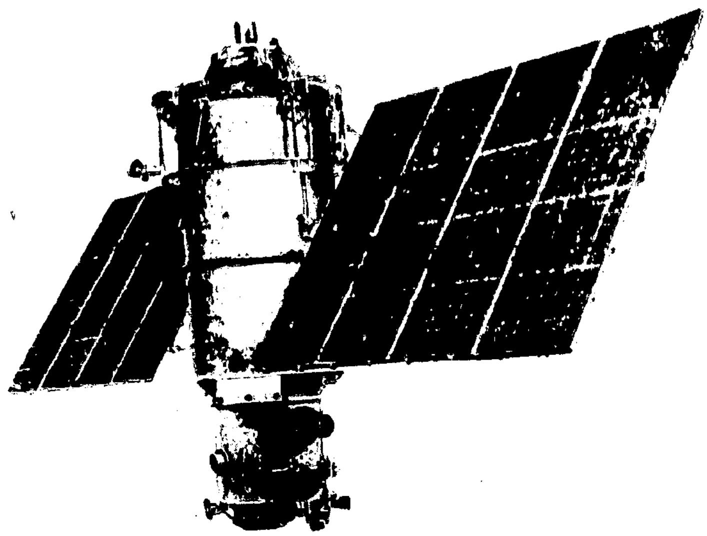

Figure 3: General view of "Kosmos-144" satellite.

The apparatus of "Kosmos-144" enables to obtain image of cloudiness, snow-cover, ice fields on the illumines and shadow sides of the Earth, to measure flux of radiation reflected and radiated by the "earth-atmosphere" system. Telcvision appratus is used for observing cloudiness on the illumined side of the Earth. Two cameras conduct area by area photographing of the Earth's surface along the flight trajectory of the satellite. The television cameras are switched on automatically with elevation angle of the sun above the horizon 5°.

During the flight of the satellite the illuminance of the Earth considerably changes due to the changing nature of the underlying surface, as well as due to the height of the Sun. In order to obtain high-quality photographs, the exposure is controlled by an automatic device, which measures the illuminance of the Earth and fixes the required diaphragm of the topics. . From altitude of about 625 km the television cameras photograph the Earth surface along the flight trajectory of the satellite with the width of coverage about a thousand km. The high resolving power of the photographing enables to determine clearly the shape of the clouds and to analyse in detail the atmospheric processes taking place in the given area.

As an illustration we insert a photograph, obtained from the satellite on 2 March at 16 hrs 01 min on the 29th turn of its flight. The satellite's trajectory was passing over the Indian Ocean south to north. Clearly visible on thephotograph is the eastern coast of Africa, north of Zanzibar. The clear weather along the coast extends for over thousand km. About 100 km from the coast line - over enormous territory are cumulus clouds, light clouds of good weather, originating due to ascending currents. North-east from Zanzibar a considerable area is cloud-covered. In the right top corner can be clearly seen three huge sources of thick cumulus cloudiness. These rain clouds with downpour and thunder storms are considerable, and radius of one of them is about 50 km.

Observation of cloudiness on the shadow side of the Earth is implemented by means of infrared devices, measuring outgoing radiation of Earth surface and clouds, intensity of which depends on their temperature. The infrared section of the spectrum was selected for measurements on basis of the fact, that in this wave band radiation of the thermal energy by Earth surface and clouds is maximum, and radiation absorption by the Earth's atmosphere is minimum. The intensity of the outgoing heat energy is determinable by the temperature of the radiating surface, and since the clouds are always colder than the surface of the Earth, their radiation is less intensive.

Continuous intensity measuring of the heat radiation from surface "scanned" by the satellite, enables to obtain data of cloudiness not only on the shadow side, but also on the illumined side of the Earth.

As a rule, the infrared apparatus is switched on for complete flights of the satellite around the Earth. The receiver of the infrared appratus, set up on board the satellite, carries out scanning perpendicularly to the plane of the satellite's flight, this enables to obtain the width of scan band of about 1100 km. Heat radiation of the underlying surface and clouds is transformed by the apparatus into electric signals, proportional to intensity of the radiated flux. These are recorded by the memory and at present moment transmitted to Earth.

Photographs of cloud systems, obtainable by means of infrared apparatus, are in less detail, than television, but are quite adequate for the analysis of large atmospheric formations (cyclons, typhoons, atmospheric fronts) with typical cloud systems, dimensions of which are measured in hundreds and over thousand km. Information about cloudiness in polar regions, specially of the Southern hemisphere, received by means of infrared appratus, it is at present the only source of information, enabling to give the required reference as to the nature of weather in these areas.

Besides the scanners, two wide-angle cameras operate on board the satellite, covering the whole visible from the satellite disc of the Earth.

The system complex for meteorological determinations from satellite, includes points of reception, processing and transmission of data to departments of Hydrometeoservice of USSR and other countries,. Naturally, each type of determination has its own method of processing, but the common is the unusual "abundance" of information and only 96 minutes for its processing. When the satellite completes its patrol turn, information, obtained during the preceding turn, should be already processed.

Photographs, made by television cameras, have to be corrected for the unavoidable perspective distortions of the optics, which are obtained in photographing a wide strip of Earth surface. Thereafter the picture has to be tied to [illegible] locality and plotted on coordinate grid. Almost the whole of this [illegible] site procedure is accomplished by means of [illegible] electronic [illegible].

[illegible]: [illegible] north of [illegible].

The infrared image of cloudiness is transformed by means of special apparatus into macromaps of cloudiness. As a result of the study of photographs maps are compiled of the cloudiness analysis, which are transmitted to meteorological stations, air-ports and hydrometeorological bureaues.

The processing of enormous flow of data of actinometric (heat radiation) measurements is accomplished by means of special computers.

The construction of meteorological artificial Earth satellite, complex of ground equipment, control, reception and processing is a great achievement of the staff of numerous institutes designing departments and industrial undertakings of our country. This a creative contribution of an army of specialists to the chronicles of glorious achievements during the Jubilee year of the fiftieth anniversary of our Motherland.

G. Golyshev, Deputy Director of Hydrometeoservice of USSR; N. Andronov, Professor.

"Izvestiya", 16 March 1967.

"METEOR" SERVES METEOROLOGISTS.

In the Main Department of Hydrometeorological Serive with the Council of Ministers USSR.

In orbit at present are two meteorological artificial Earth satellites, which jointly with the points of reception, processing and propagation of meteorological information form experimental meteorological space system "Meteor".

The Main Department of the Hydrometeorological Serive jointly with representatives of scientific and industrial organizations have analyzed the results of meteorological observations, being conducted by means of two artificial Earth satellites - "Kosmos-144" and "Kosmos-156".

As informed by TASS, an artificial Earth satellite "Kosmos-156" was placed into orbit on 27 April 1967. "Kosmos-156" just as its predecessor "Kosmos-144", launched on the 28 February 1967, implements an extensive program of meteorological observations.

The satellite carries the following:

- television camera, meant for recording pictures of cloud-, snow- and ice-covers on the day-side of the Earth;

- infrared camera for recording pictures as above on the shadow side of the Earth;

- actinometric instruments for intensity recording of radiation, emitted and reflected by the Earth - atmosphere system, and for measuring temperature of the clouds and underlying surface.

The meteorological information is recorded by devices on board the satellite with memorization and subsequent transmission to ground stations.

For geographical tying of meteorological data the satellite has functioned systems implementing continuous exact orientation of the satellite to earth and in flight direction, as well as synchronization of all recording and memorizing devices.

The power supply of the satellite's devices is provided by the solar batteries with independent orientation system on the sun and chemical batteries of required automatics.

The satellite has also radiotelemetry and systems assuring exact measurements of orbital elements.

The meteorological data from both the satellites is received by a network of specially constructed ground points, equipped with the means for recording and processing of data and connected by direct communication channels with the Hydrometeorological Center of USSR.

The reception points of meteorological data conduct by means of automatic devices and computers decoding, geographical tying and processing of television, the infrared and actinometric information.

The appratus, set up on "Kosmos-144" and "Kosmos-156", and also the ground complex of reception, processing and propagation of meteorological information for the experimental sapce meteorological system "Meteor".

The experimental system "Meteor" is meant for a regular gathering of meteorological information, which will be processed in Hydrometeorological Center of USSR and used by the operative weather service in the interest of National economy and for International exchange.

(TASS)

In Jubilee year of 1967 will be ten years since the launching of the first artificial Earth satellite. Our Motherland was the first to open a way for the man into the outer space, an era of peaceful use of the space. The accomplishment of a ten-year program of space investigations is a clear demonstration of enormous achievements of the Soviet science and technique.

Investigations of the physical conditions in the outer space, in which for a long time operate composite automatic space observatories, enabled to construct modern meteorological Earth satellites, the use of which opens out a vast possibilities fof meteorology.

The present-day weather service is at the stage of extremely quick reconstruction. If in the past the weather forecast was estimated for the agricultural activity in the relatively small areas within the country. now the task of meteorologists has sharply changed. Thus, for instance, Soviet airliners, flying out of Moscow, reach within 10-12 hrs points, located in another hemisphere of the Earth. Regular routes, extend for over ten thousand km cover practically the whole globe. Such are the regular airlines to Cuba, Montreal, Tokyo, inter continental flights to Antarctic regions. This requires complete information regarding the state of atmosphere on the scale of the whole Earth.

Not less important are the exact weather forecasts also for the ships at sea and fishing fleet. Their sphere of activity now is the World ocean. The efficiency of the seamen and fishermen is determined to a considerable extent by the correct estimate of hydrometeorological environment, which is formed at sea.

The former organization of weather service cannot satisfy the growing needs. Not only that the information has to be gathered from any point of the globe, it has to be received in time and concentrated in meteorological centers during a very brief period.

In order to manage one of the most difficult problems of contemporary science - reliable long-term weather forecast, the meteorologists have to work out a theory of the total atmospheric circulation on the Globe. The construction of this theory, taking into account the whole complexity of processes, active in the air ocean of the Earth, is impossible without the systematic meteorological observations throughout the whole surface of the Globe. With the usual technical means, which were previously at the disposal of meteorologists, it could not be done, as vast ocean spaces and little-populated territories of the Globe remain practically without meteorological observations. And only the meteorological satellite - "cosmic eye", shifting along an orbit, is capable to follow the weather on the whole of the planet.

The synoptic meteorologists of our days cannot imagine analysis of atmospheric processes without the use of satellite's information - so quickly and decisively it became one with the weather service. By means of the satellites the science of atmosphere becomes enriched by information about the heat radiation flux, piercing the air ocean of the Earth. Without these data it is impossible to estimate the action of "heat engine", activating the atmosphere.

For quantitative estimates of atmospheric processes, on which the modern methods of numerical short-term and long-term weather forecasting are based, the global information of meteorological satellites is specially important.

Development of experimental space system "Meteor", composition of which includes artificial Earth satellites, points of reception and processing of data, department for the control of state and performance of systems on board, required resolution of many scientifical and technical problems. They were successfully managed by the staff of research institutes, designers and industrial organizations.

Since the complete analysis of the state of atmospheric processes can be implemented only with an estimate of a number of met ·ological characteristics, it was decided to construct a satel .te, providing for simultaneous measurements of the radi· .on flux in various sections of the spectrum and photographing of loud-cover in visible and infrared rays. This is carried out by a complex of scientific apparatus, which includes television ·· eras of day and night visibility, infarred equipment for temperature measuring of the Earth's and cloud surface, and actinometers for measuring reflected and emitted heat energy of the Earth and atmosphere.

The complex of scientific apparatus has special requirements of power, orientation and stabilization of the satellite. The need in the orbit is not only to record the atmospheric processes, but also to "memorize" the obtained information, to assure its correct geographical tying. The main significance has the duration of the active existence of the satellite in the orbit and, finally, non-failure of the various electrotechnical and radio-technical systems,.

The development of meteorological satellites begun in accordance with program for construction of satellites of "Kosmos" series, announced on the 16 March 1962.

Constructed and tested at the first stage were the electrotechnical devices on "Kosmos-23" providing for stabilization of the satellite and orientation of its body on the center of the Earth. The performance was thoroughly checked of the power system automatics, controlling solar and chemical batteries.

Investigations of solar batteries have shown, that with prolonged effect on them of the cosmic matter, and with long-term working there is ageing of photocells and change in their specifications. This results in decreased efficiency of the batteries.

The investigation results were used in construction of more perfect power sources on the subsequent types of satellites.

At the second stage of working on the experimental meteorological system "Kosmos-122" was constructed and tested. In this satellite the set of devices for meteorological observations - television, actinometric, infrared - was combined with a system, assuring many months function of satellite in the orbit. To provide for such a long-term performance of the satellite required resolution of multiple composite technical problems. Thus, two independent orientation systems were used on "Kosmos-122": one - for continuous orientation of the device compartment on the Earth, the other - for orientation of solar batteries on the Sun.

As orientation sensors on the Sun the application was of special photocells, reacting only to a certain part of its rays spectrum. For orientation determination on Earth the application was of devices, reacting to its heat radiation, the sensors of which are highly sensitive to various electromagnetic interference. Appropriate measures were taken to eliminate the effect of any interference on board the meteorological satellite.

Special study was conducted of the bearing nodes of electric engines and other mechanisms in conditions of deep vacuum - in the outer space. Great attention was paid to the questions of thermal regulation for assuring normal conditions inside the satellite for all the instruments, sensitive to temperature variations.

The third stage of constructing experimental meteorological system was marked by the launching on 28 February and 27 April of the current year of "Kosmos-144" and "Kosmos-156" into near circular orbits, passing at altitude 625-630 km above the Earth.

The launching of satellite "Kosmos-156" was carried out with an estimate for the initial plane of its orbit to be displaced in the relation to the orbital plane of "Kosmos-144" by 95°.

Each of the satellites, which entered today into the experimental meteorological system "Meteor" enables to obtain during only one orbital period information regarding cloudiness from a territory, composing about 8 %, and data on the radiation flux - approximately from 20 % of the Globe's surface.

The reciprocal position of the satellites orbits is selected so, that they conduct weather observations above each of the development of atmospheric processes in various areas of the Globe. The existing system of the two satellites makes it possible even now to obtain within 24 hours meteorological information from half the surface of our planet.

With simultaneous orbiting of several meteorological satellites the problems of their control and that of the system as a whole become considerably more complicated.

For a normal functioning of a system of meteorological satellites requires with the passage of each of them above the reception points quick processing of telemetric information, which contains meteorological data and information regarding the performance of apparatus on board.

This composite problem has been successfully resolved by means of ground control complex. The telemetric information is put into the quick-acting computers, Almost immediately the communication ceases with satellite the computers complete processing of all telemetric data, edit them and issue in the form convenient for use.

Before the information arrives from the next orbit the meteorological data should be fully processed and presented in the form of charts and maps for an operative weather service.

These data quickly reach the meteorological departments within the country, as well as abroad. This is done by special communication channels, which enable to transmit by wire or radio weather maps, charts and photographs of cloud-cover.

Information incoming from "Kosmos-144" and "Kosmos-156" is widely used in the daily work of the weather service research centers. In Hydrometeorological Research Center of USSR the analysis are verified by means of this information of synoptic maps, and also weather forecasts for 1-3 days ahead. The material from satellites is specially useful in the analysis of the state of weather above areas with a sparse network of meteorological stations. Thus, at present the information of "Kosmos-144" and "Kosmos-156" is successfully used in forecasting wind and swell in conducting through several oceans of a large floating dock, which is now in the Pacific Ocean. Great interest represent also data on position of ice in the Arctic Ocean, obtained from the satellites. Now this cosmic ice survey above the areas of the Arctic Ocean is of special value due to the navigation beginning along the Northern sea route.

The experimental meteorological system "Meteor" is the result of implementing an extensive program of work on the use of artificial Earth Satellites in the interest of National economy of our country.

"Pravda" June 4, 1967.

CHAPTER - III

SPACECRAFT FOR MOON INVESTIGATION.

Tass Communique on the Launching of Cosmic Rocket toward the Moon.

The years 1957-1958 were marked by the greatest achievements of the Soviet Union in the sphere of rocket construction. The launching of the Soviet artificial Earth satellites enabled to accumulate the material required for accomplishment of cosmic flights and reaching other planets of the Solar System. The research and designing carried out in the USSR were directed toward construction of artificial Earth satellites big in size and weight. The weight of the third Soviet satellite, as we know, composed 1327 kg.

With successful launching on the 4th of October 1957 of the first in the world artificial Earth satellite and subsequent launching of heavy Soviet satellites according to IGY program the first space velocity - 8 km per second was obtained.

As a result of further creative work of the Soviet scientists, designers, engineers and workers a multistage rocket has been constructed at present, the last stage of which is capable of attaining the second space velocity - 11.2 km/sec, assuring the possibility of interplanetary flights.

On the 2nd of January 1959 the launching of a space rocket toward the Moon was carried out in the Soviet Union. The multistage space rocket was directed according to preset program on the flight path toward the Moon. According to tentative data, the last stage of the rocket has obtained the required second space velocity. Continuing its flight, the rocket intersected the eastern boundary of the Soviet Union, passed above the Hawaiian islands and is flying above the Pacific Ocean, rapidly receding from the Earth.

On 3rd January at 3 hrs 10 min Moscow time the space rocket on its flight toward the Moon will pass above the southern part of Sumatra, being at a distance from the Earth of above 110 thous. km. According to tentative calculations, which are being verified by direct observations, the space rocket should reach the area of the Moon at about 7 hrs on the 4th January 1959.

The last stage of the rocket weighing 1472 km without fuel is equipped with a special container with measuring instruments for the following scientific investigations:

- detection of the Moon's magnetic field;
- intensity and its variations study of cosmic rays beyond the magnetic field of the Earth;
- photons recording in cosmic radiation;
- detection of the Moon's radioactivity;
- distribution of the study of heavy nuclei in cosmic radiation;

- study of the gas component of interplanetary matter;
- corpuscular radiation study of the Sun;
- meteor particles study.

To observe the flight of the rocket's last stage it carries:

- radio-transmitter, emitting on frequencies 19.997 and 19.995 megacycles per second telegraphic sendings lasting 0.8 and 1.6 seconds;
- radio-transmitter, operating on frequency 19.993 mcps in telegraphic sendings of variable duration about 0.5-0.9 sec, used for transmitting data of scientific observations;
- radio-transmitter emitting on frequency 183.6 mcps, used for measuring parameters of flight and transmission to Earth of scientific information;
- special apparatus, meant for creating sodium cloud - artificial comet.

The artificial comet can be observed and photographed by optics, provided with light filters, which separate the spectral line of sodium.

The artificial comet will be formed on 3rd January at about 3 hrs 57 min Moscow time and will be visible for 2-5 min in the vicinity of Virgo constellation, approximately in the center of triangle, formed by the stars alpha Bootis, alpha Virgo and alpha Libra.

The space rocket carries on board a pennant with the National Emblem of the Soviet Union and inscription: "Union of the Soviet Socialistic Republics. January, 1959".

Total weight of the scientific and measuring instruments with power sources nd container composes 361.3 km.

The scientific stations in various areas of the Soviet Union observe the first interplanetary flight. The trajectory elements are determined on computers from the measuring data, incoming automatically to coordinating-computing center.

The processing of measuring results will enable to obtain data on the flight of space rocket and to determine those sections of interplanetary space, in which the scientific observations are being conducted.

The constructive work of all the Soviet people, directed toward resolving the most important problems of socialist community in the interest of all progressive mankind, made it possible to accomplish the first successful interplanetary flight.

The launching of the Soviet space rocket once again shows the high level in the development of the national rocket-construction and again demonstrates to the world the outstanding achievement of the advanced Soviet science and technique.

The greatest mysteries of the Universe will become more attainable to the man, who in the near future will be able to step on the surface of other planets.

The staff of Research Institutes, designing departments, factories and test organizations, who constructed new rocket for interplanetary communications, dedicate this launching to the XXI Convention of the Communist Party of Soviet Union.

Transmission of data on the flight of the space rocket will be regularly conducted by all radio-stations of the Soviet Union.

To Scientists, Engineers, Technicians, Workers, the entire Staff, participating in construction and launching of space rocket.

The construction of multistage space rocket and its successful launching toward the Moon on the 2nd January 1959 marks the greatest achievement of the Soviet science and technique.

The first interplanetary flight of the Soviet space rocket opens out a glorious page in the study of the outer space and demonstrates to the mankind the creative genious of the free Soviet people and gigantic scientific and technical progress, attained by the workers of the (first in the world) country of victorious socialism.

"Pravda", 3rd January 1959.

The Central Committee of the Communist Party of the Soviet Union and the Council of Ministers of USSR congratulate scientists, engineers, technicians, workers and all the staff, participating in construction and launching of the space rocket.

Dear Comrades ! The Party, Government and all Soviet people highly value your selfless labor and are firmly convinced, that many times more will you gladden our beloved Motherland and the entire progressive mankind by new discoveries and achievements of universal significance.

Glory to the toilers of Soviet science and technique, paving new paths to uncovering the mysteries of nature and subjugating its forces for the good of mankind.

Central	Council
Committee of	of Ministers
CPSU	USSR

THE FLIGHT OF SOVIET SPACE ROCKET CONTINUES.

At 10 hrs on the 5th January the Soviet space rocket continues its flight.

On 5th January the incoming from the rocket radio-signals have considerably attenuated.

"Pravda", 4th January 1959.

Due to consumption of power supply resources the reliable radio-communication with the rocket ceased on 5th January at about 10 hrs Moscow time.

During the 62 hrs of its flight from the moment of launching the space rocket receded from the Earth at 597 thous.km at 10 hrs. on the 5th January. On this flight path 34 hrs after start it passed in the vicinity of the Moon and, overcoming the attraction of the Earth and the Moon is coming out on its orbit around the Sun.

For 62 hrs, according to program, there was a steady communication of rocket with the Earth which enabled to observe the flight of the rocket and to get the information about the performance of scientific instruments aboard the rocket.

The program of research investigations and observations of the rocket is completed.

The space rocket will finally come out into periodical orbit of artificial planet on the 7-8th January of current year.

The artificial planet orbit is between the orbits of the Earth and Mars.

The least distance between the orbits of artificial planet and Mars composes about 15 mln km, which is approximately a quarter of the distance Earth and Mars during the favorable opposition of Mars.

Flying along its orbit around the Sun with orbital period 450 terrestrial days, the artificial planet after about five years will again approach the Earth, however, its distance from the Earth will be in the order of some tens of millions of km.

The tasks, set in the launching of space rocket, are accomplished.

Valuable material was obtained for further development in construction of interplanetary rockets, as well as important results on further space radio-communication, a number of investigations was carried out of high scientific significance on physical problems of the outer space, expanding our knowledge of the Universe.

The obtained scientific results will be published with processing of observations.

After the construction by the Soviet Union of the first artificial Earth satellite the launching on the 2nd January 1959 of the Soviet space rocket, which has become forever the first artificial planet of our Solar System, is a majestic event of the epoch of building communism and opens out an era of interplanetary flights.

"Pravda", 6th January 1959.

SOVIET SPACE ROCKET.

On 2nd January 1959 a successful launching was accomplished in the Soviet Union of space rocket toward the Moon. For the first time in the history of mankind a spacecraft was constructed, which not only attained, but even exceeded the second space velocity. The last stage of the rocket, weighing 1472 kg (without fuel), passed in the vicinity of the Moon and became the first artificial plane of the Solar System.

This event marks the new stage on the path of mastering the outer space. The creative labor of Soviet people has brought into being a new celestial body, which has overcome the terrestrial gravity and is flying along an elliptical orbit around the Sun.

The construction of the space rocket was the natural continuation of work on intercontinental rockets and large artificial Earth satellites, conducted in the Soviet Union. It is a known fact, that the weight of the third Soviet satellite is 1327 kg. All this work has enabled to accumulate the required experience for constructing large space vehicles.

The flight of the rocket in the outer space has made it possible to accomplish a set of the most important scientific experiments on the investigation of interplanetary matter. For the first time the possibility has been realized for conducting direct scientific measurements in extensive program at such great distances from the Earth.

The launching of the space rocket is another outstanding success of the Soviet science and technique. For accomplishing the space flight a multistage rocket was constructed, distinct by high constructive perfection, with powerful highly-effective rocket engines. Flight control of the space rocket during its insertion into preset trajectory was accomplished with high precision by means of special automatic system.

To implement the program of research experiments the construction was of unique scientific instruments and special radio-metering systems. Total weight of scientific and measuring instruments with power sources and container composes 361.3 kg. Theflight trajectory in the outer space was controlled by means of a set of radio-technical means, which enabled to determine the coordinates and velocity of the rocket at every moment of its flight.

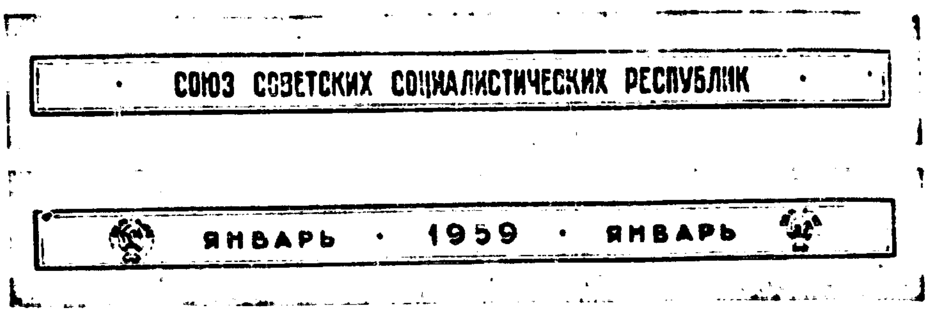

Fig.1. The pennant (from the right and reverse sides), on board the space rocket.

The launching of the Soviet space rocket denotes the entry of mankind into the era of interplanetary flights. The next stages on this course should be further investigations of outer circumsolar space, investigations of the Solar System planets and manned flight to other planets.

Scientists, , designers, engineers, technicians, workers and testers, whose inspired creative labor inscribed a new page into the history of the world science and technique, dedicated the launching of the space rocket to the XXI Convention of the Communist Party of the Soviet Union.

All Soviet people are discussing the majestic program of building up communism in our country, put forward in summaries at the XXI Convention of the Communist Party of the Soviet Union. Implementation of this program under the leadership of the Communist Party and the Soviet Government will assure new, even more vigorous uplift of the national economy in our country and will bring the Soviet people to conquering new peaks in every sphere of science and technique undoubtedly we shall witness in the next few years new outstanding successes of our country in mastering the outer space and discovery of new secrets of the nature for the good of the Soviet people and the entire progressive mankind.

The high appreciation by the Central Committee of CPSU and the Council of Ministers USSR of the work of scientists, engineers, technicians and workers, who constructed the multistage rocket and accomplished its successful launching toward the Moon on the 2nd January 1959, inspires the staff of Research Institutes, Designing Departments, factories and test organizations to selfless labor for attaining new successes in the mastering of the outer space.

The Flight of the Space Rocket.

The multistage space rocket started from the Earth surface vertically. Under the effect of the programming mechanism of automatic system controlling the rocket, its trajectory gradually deviated from the vertical. The velocity of the rocket quickly increased. At the end of the acceleration section the last stage of the rocket picked up the velocity, required for its further flight. The automatic control system of the last stage switched off the rocket engine and gave the command for the separation of container with research instruments from the last stage. The container and the last stage came out onto the trajectory and began their flight toward the Moon, remaining at close distance from each other.

In order to overcome the terrestrial attraction, the space rocket should pick up velocity not below the second space velocity. The second space velocity, known also as the parabolic velocity, composes on the surface of the Earth

11.2 km/sec. This velocity is critical in the sense, that at lower velocities, known as elliptical, the body either becomes the Earth satellite, or rising to a certain ultimate altitude, returns to Earth. At velocities, higher, than the second space velocity (hyperbolic velocities) or equal to it, the body is capable of overcoming the terrestrial attraction and receding from the Earth for ever.

The Soviet space rocket at the switch-off moment of the last stage rocket engine have exceeded the second space velocity. The main effect on the further flight of rocket, prior to its approach to the Moon, is of the gravity force of the Earth. As a result of this, according to celestial mechanics, the flight trajectory of the rocket in relation to the Earth's center is almost a hyperbola, for which the Earth's center is one of its foci. The trajectory is more curved close to the Earth and straightens out with receding from the Earth. At great distances from the Earth the trajectory becomes almost a straight line. At the start of the rocket's flight along a hyperbolic trajectory its velocity is very high. However, with withdrawal from the Earth, the velocity of rocket decreases under the effect of terrestrial force. Thus, if at altitude of 1500 km the velocity of rocket in relation to the center of the Earth was slightly over 10 km/sec, at altitude of about 100 thous.km it was about 3.5 km/sec.

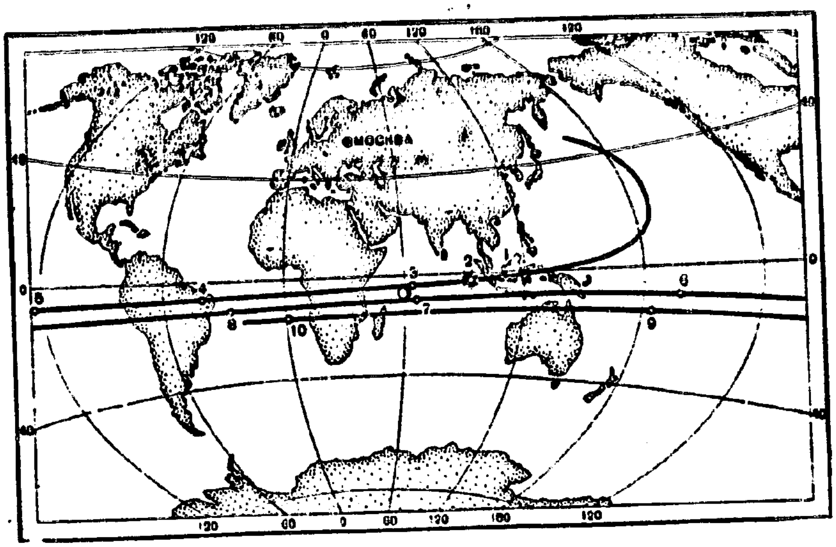

Fig.2. Course diagram of the space rocket.

The figures in diagram correspond to successive position of the rocket's projection on the Earth's surface.

1-3 hrs 3rd January, 100 thous.km from the Earth;

2- formation of artificial comet;

3-6 hrs, 137 thous.km;

4-13 hrs, 209 thous.km;

5-19 hrs, 265 thous.km;

6-21 hrs, 284 thous.km;

7-5 hrs 59 min 4th January, 370 thous.km -instant of the nearest approach to the Moon;

8-12 hrs, 422 thous.km;

9-22 hrs, 510 thous.km;

10-10 hrs 5th January, 597 thous.km.

The rotational speed of radius vector, connecting the center of Earth with rocket, decreases according to Kepler's inverse-square law. If at the start of flight this speed was about 0.07 degree/sec, i.e. exceeded more than 15 times the daily rotation of the Earth, after about one hour it became lower than the angular velocity of the Earth. But when the rocket approached the Moon, the rotation speed of its radius vector reduced by more than 2000 times and became five times less than the angular velocity of the Moon's rotation about the Earth. Whereas the rotational speed of the Moon is only 1/27 of the Earth's angular velocity.

These peculiarities of the rocket's movement along the trajectory determined the nature of its displacement in relation to Earth surface.

The map shows time displacement of the rocket's projection on the Earth's surface. As long as the rotational speed of radius vector of the rocket was high in comparison to rotational speed of the Earth, this projection was displaced eastward, gradually deviating to the south. Thereafter this projection began shifting initially south-west and after 6-7 hrs after the start of the rocket, when rotation velocity of radius vector became very low, almost excactly west.

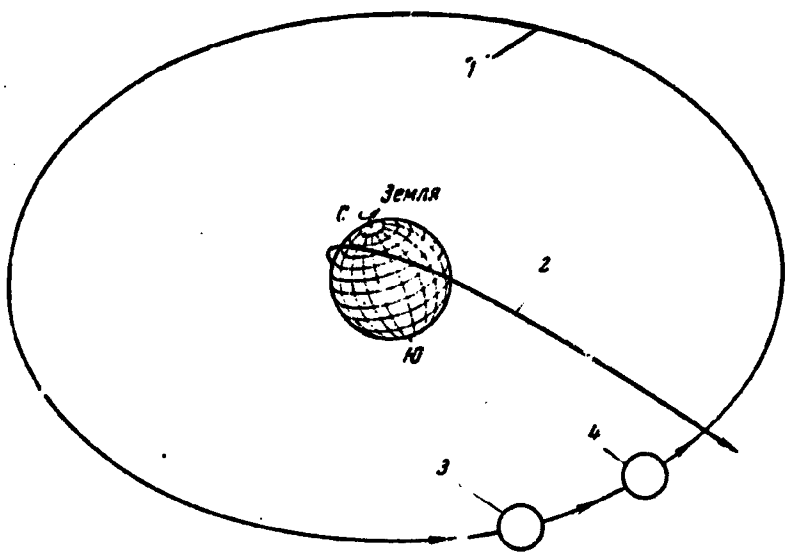

Fig.3. Approach path of rocket to the Moon.

1- Moon orbit; 2- rocket path; 3- position of Moon at the start of rocket; 4- position of Moon at the moment of rocket approach.

The movement of the rocket among the constellations in celestial sphere is shown on diagram in figure 4. The movement of the rocket in celestial sphere was very irregular - fast at the start and very slow at the end.

After about an hour of flight the path of the rocket in celestial sphere entered into constellation Coma Berenices. Thereafter the rocket passed into constellation Virgo, in which its approach to the Moon took place.

On the 3rd January at 3 hrs 57 min Moscow time, when the rocket was in the constellation Virgo, approximately in the middle of triangle, formed by the stars Arctur, Spica and Alpha of Libra, an artificial comet was created by means of special device aboard the rocket, made up of sodium vapors, luminescent in the Sun's rays. This comet could be observed from the Earth by optics for several minutes. During the passage close to the Moon the rocket was between the stars Spica and Alpha of Libra.

The rocket path in celestial vault on approach to the Moon is inclined to the Moon's path at about 50 degrees. In the vicinity of the Moon the rocket's movement in celestial sphere was about 5 times slower, than that of the Moon.

The Moon, orbiting about the Earth, approached the point of convergence with the rocket from the right, if we look from the northern part of the Earth. The rocket approached this point from above and from the right. During the period of maximum convergence the rocket was above and slightly to the right of the Moon.

The flight time of rocket to the Moon's orbit depends on the excess of the initial velocity of the rocket over the escape velocity and the higher is this excess, the shorter will be this time. This excess was selected with an estimate, that the passage of the rocket in the vicinity of the Moon could be observed by means of radio-stations, located on the territory of the Soviet Union and other countires of Europe, as well as in Africa and major part of Asia. The flight time of space rocket to the Moon was 34 hours.

During the maximum convergence distance between the rocket and the Moon, according to confirmed data, was 5-6 thous.km, i.e. one and a half diameters of the Moon.

When the space rocket approached the Moon at a distance of some tens of thousands km, the attraction of the Moon began to have a noticeable effect on the movement of the rocket. The effect of the Moon's gravitation resulted in deflecting the direction to the rocket's movement and change in velocity of its flight in the vicinity of the Moon. In convergence the Moon was lower than the rocket, and therefore, due to the gravitation of the Moon, the flight direction of the rocket deflected downward. The gravitation of the Moon also built up a local velocity increment. This increment reached maximum in the area of the maximum convergence.

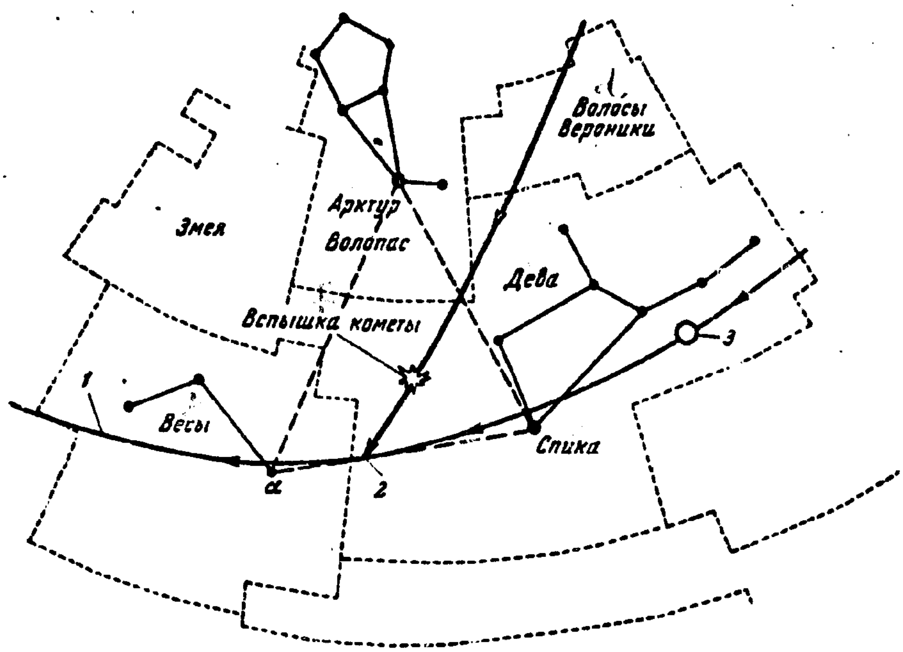

Fig.4. Diagram of rocket path toward the Moon on celestial ma.

1- Moon orbit; 2- convergence point of rocket with the Moon; 3- the position of the Moon at the moment of the rocket's start.

a- Serpens; b- Arctur; c- Booties; d- Coma Berenices; e- Virgo; f- flare of the comet; g- Libra; h- Spica.

After convergence with the Moon the space rocket continued to recede from the Earth, its velocity in relation to the center of Earth decreased, approximating about 2 km/sec.

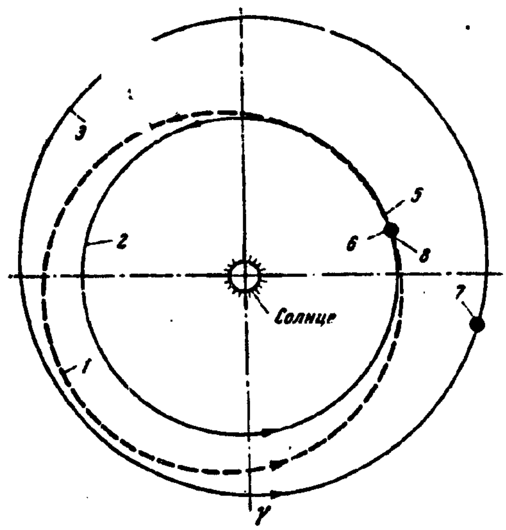

Fig.5. Calculated orbit of artificial planet in relation to the Sun (the planet is shown on the chart at the moment of maximum convergence of rocket with the Moon).

1- aphelion of the artificial planet; 2- the Earth's orbit; 3- Mars orbit; 4- artificial planet orbit; 5- perihelion of artificial planet; 6- Earth; 7- Mars; 8- the point of rocket's entering an orbit.

At a distance from the Earth of about one million km and over the effect of the Earth's gravitation on the rocket is attenuated to an extent, when the movement of the rocket may be assumed to be occurring only under the effect of the Sun's gravity force. About the 7-8th January the Soviet space rocket entered its own independent orbit around the Sun, became its satellite, transforming into the first in the world artificial planet of the Solar System.

The velocity of the rocket in relation to the Earth's center during the 7-8th January was directed approximately in the same way, as the velocity of the Earth in its rotation around the Sun. Since the Earth's velocity is 30 km/sec, and the velocity of rocket in relation to Earth - 2 km/sec, the velocity of rocket, as a planet around the Sun was approximately 32 km/second.

The exact data on position of the rocket, its direction and velocity at great distances from the Earth make it possible to estimate according to laws of celestial mechanics the movement of the space rocket as a planet of the Solar System. The estimate of orbit was done without accounting for disturbances, which may be caused by the planets and other bodies of the Solar system. The estimated orbit is characterized by the following data:

- inclination to orbital plane of the Earth about 1°, i.e. very low;
- orbitaleccentricity of the artificial planet is 0.148, which is more noticeable, than the eccentricity

of terrestrial orbit, equal to 0.017;

- minimum distance from the Sun is about 146 mln km, i.e. only a few mln km less, than the distance of Earth from the Sun (mean distance of Earth from the Sun is 150 mln km);
- maximum distance of artificial planet from the Sun will be about 197 mln km, i.e. the space rocket in this case will be 47 mln km further from the Sun, than the Earth;
- the orbital period of the artificial planet around the Sun will be 450 days, i.e. about 15 months. The minimum distance from the Sun will be attained for the first time in the middle of January 1959, and the maximum - at the beginning of September 1959.

It is interesting to note, that the orbit of the Soviet artificial planet approaches the orbit of Mars at a distance of about 15 mln km, i.e. approximately four times closer than that of the Earth.

Distance between the rocket and the Earth in their movement around the Sun will vary, some times increasing, sometimes decreasing. Maximum distance between them could reach upto 300-350 mln km.

During the rotation of the artificial planet and the Earth around the Sun they may converge at a distance of about a million km.

The Last Stage of the Space Rocket and Container with Research Instruments.

The last stage of the space rocket is a controllable rocket, attached by means of adapter to preceding stage.

The rocket is controlled by automatic system, stabilizing the position of the rocket on the preset path and providing for the estimated velocity at the end of the engine's work. The last stage of the space rocket after consumption of the fuel reserve weighs 1472 kg.

Besides devices, assuring normal flight of the last rocket stage, its body carries the following:

- hermetic, separatable container with scientific and radio-technical instruments;
- two transmitters with antennas, operating on frequencies 19.997 and 19.995 megacycles per second;
- cosmic rays counter;
- radio-system, by means of which the flight path is determined of the space rocket and its further movement is forecast;
- device for the formation of artificial sodium comet.

The container is arranged at the top of the space rocket's last stage and protected from heating during the rocket's transition through compact atmospheric layers by jettisonable nose.

The container is made up of two spherical fine half-sheaths, hermetically joined by frames with packing of special rubber. One of the half-sheaths of container carries 4 antenna rods of the radio-transmitter, operating on frequency 183.6 mega cycles per second. These antennas are fixed on the body symmetrically in relation to the hollow aluminium probe, at the end of which is a sensor for measuring magnetic field of the Earth and detecting magnetic field of the Moon. After jettisoning of the nose the antennas open out. The same half-sheath carries two proton traps for detecting gas component of interplanetary matter and two piezoelectric sensors for the study of meteor particles.

The half-sheaths of container are made of special aluminium-magnesium alloy. On the frame of the bottom half-sheath is fixed instrument frame of tubular construction from magnesium alloy, carrying instrument of the container.

Carried inside the container are the following apparatus.

1. Apparatus for radio-control of the rocket's flight path, consisting of transmitter, operating on frequency 183.6 megacycles per second, and receiver block.
2. Radio-transmitter, operating on frequency 19.993 megacycles per second.
3. Telemetry block for transmitting research data and data of pressure and temperature within the container to the Earth by radio-systems.

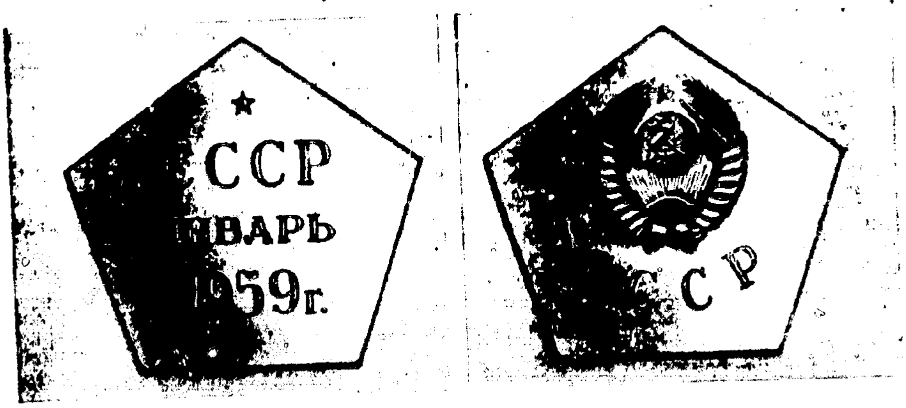

Fig.6. Pentagonal elements of the spherical pennant.

4. Apparatus for the study of gas component of the interplanetary matter and corpuscular radiation of the Sun.
5. Instruments for measuring magnetic field of the Earth and detection of the Moon's magnetic field.
6. Appratus for the study of meteoric particles.
7. Instruments for recording heavy nuclei in the primary cosmic radiation.
8. Instruments for recording intensity and its variation of cosmic rays and photons in cosmic radiation.

The radio and research apparatus of container are energized from silver-zinc accumulators and mercury oxide-zinc cells, arranged on the instrument frame of container.

The container is filled with gas at pressure 1.3 atm. The construction of container ensures high tightness of the inside volume. Gas temperature inside the container is maintained within the set limits (about 20°C). These temperature conditions are provided by imparting to the shell of container certain factors of reflection and irradiation by special processing of the shell. Moreover, the container is fitted with a ventilator, providing forcible circulation of gas. Gas circulating in container draws heat from the instruments and gives it over to the shell, which is a unique radiator.

Separation of container from the last stage of the space rocket occurs after the engine of the last stage ceases operating.

This separation is necessary from the viewpoint of ensuring thermal conditions of container. The fact is, that the instruments inside the container give off a great amount of heat. The thermal conditions, as mentioned above, are provided by retaining certain balance between heat irradiated by container shell, and heat, obtained by the shell from the Sun.

The separation of container provides normal working conditions of antennas and instruments for the measuring of magnetic field of the Earth and detection of the Moon's magnetic field; as a result of container's separation the magnetic effects are eliminated of the metal construction of the rocket on magnetometer reading.

The total weight of research and measuring instruments with container and power supply sources on the last stage of the space rocket composes 361.3 kg.

To mark the construction in the Soviet Union of the first space rocket, which has become an artificial planet of the Solar System, the rocket carries two banners with the State emblem of the Soviet Union. The banners are within the container.

One banner is in the shape of a fine metal tape. On one side of the tape is the inscription: "Union of the Soviet Socialist Republics", and on the other are the emblems of the Soviet Union and inscription: January 1959 January". The inscriptions are applied by a special photochemical method, ensuring their remaining intact for a long time.

The second banner is of a spherical shape, symbolizing the artificial planet. The sphere's surface is covered by pentagonal elements of stainless steel. Engraved on one side of each is the inscription: USSR January 1959", and on the other - emblem of the Soviet Union and inscription "USSR".

The Set of Measuring Instruments.

To observe the flight of the space rocket, measuring orbital parameters and data reception of scientific measurements the use was made of a large measuring complex, spread out through the whole of the Soviet Union.

This complex included a group of automatic radar stations, meant for exact determination of orbital elements in the initial section; a group of radiotelemetric stations for recording of scientific information, transmitted from aboard the space rocket; radio-technical system for controlling path elements of the rocket at great distances from the Earth; radio-stations for reception of signals on frequencies 19.997; 19.995 and 19.993 megacycles per sec; observatories for observing and photographing of artificial comet.

A timing apparatus and radio-communication system were used for coordinating the work of the stations and typing of results to astronomical time.

Data processing of the path's elements measuring, incoming from the areas of the stations, orbital elements determination and issue of instructions to the stations were implemented by coordinating-computing center by means of computers.

The automatic rada.. stations were used for quick determinations of the initial flight conditions of the space rocket, issue of long-term forecasting of the movement of the rocket and instructions to all measuring and observing stations. Measuring data of these stations were converted by means of special computers into binary code, averaged, tied to astronomical time with precision upto a few milliseconds and automatically issued into communication lines.

In order to prevent possible errors in measuring data in transmission along the communication lines, the measuring information was coded. The application of code enabled to find and correct one error in the figure being transmitted and to find and throw aside figures with two errors.

The transformed measuring information arrived at the coordinating center. Here by means of input devices the measuring data were punched on cards, from which the electronic computers carried out joint processing of measuring results and orbital estimates. The initial flight conditions of the space rocket were determined on basis of a great amount of trajectory measurements as a result of resolving the boundary-value problem with the use of least squares method. Next followed integration of a system of differential equations, describing the joint movement of the rocket, Moon, Earth and Sun.

The telemetric ground stations received information from the space rocket and recorded it on photofilms and magnetic tapes. To provide a greater reception distance of radio-signals highly-sensitive receivers were used and special antennas with considerable effective area.

Radio-stations, operating of frequencies 19.997, 19.995 and 19.993 megacycles per second, received radio-signals from the space rocket and recroded them on magnetic tape. In this case measurements were conducted of the intensity of the field and a number of other measurements, enabling to conduct ionospheric investigations.

By changing the manipulation type of transmitter on frequencies 19.997 and 19.995 megacycle per second, data were transmitted on cosmic rays. Along the channel of transmitter on frequency 19.993 megacycles per second the main scientific information was transmitted by changing duration of interval between the telegraphic sendings.

For optical observation of the space rocket from the Earth to confirm the passage of space rocket along the given section of its path an artificial sodium comet was used. This artificial comet was formed on the 3rd of January at 3 hrs 57 min Moscow time at a distance of 113 thousand km from the earth. The artificial comet could be observed from areas of Central Asia, Caucasus, Near East, Africa and India. The comet was photographed by means of a specially constructed optical apparatus, set up in the southern astronomic observatories of the Soviet Union. To enhance the contrast of photographic imprints light filters were used, which separate the spectral line of sodium. In order to enhance the sensitivity of photographic cameras a number of installations were equipped with electronic image transformers.

In spite of the bad weather in majority of areas of optical observations of the rocket, it was possible to obtain several photographs of the sodium comet.

Orbital control of the space rocket upto distances 400-500 thous.km and elements determination of its path were conducted by means of a special radio-technical system, operating on frequency 183.6 megacycles per second. At exactly determined moments the measuring data were automatically derived and fixed in the digital code on special appliances.

Jointly with the time, during which the reading was taken of the radio-technical system, these data were quickly arriving at the coordination center. Joint processing of these measurements with data of radar system enabled to verify the orbital elements of the rocket and to control directly the movement of the rocket in space.

The use of powerful ground transmitters and highly-sensitive receivers provided for assured determination of the space rocket path upto about 500 thous.km.

Application of the above measuring stations enabled to obtain valuable data of scientific investigations and to control and forecast reliably the movement of the rocket in the outer space.

The abundant material of the path determinations, implemented during the flight of the first Soviet space rocket, and experience of the automatic data processing on electronic computers will be of great significance in the launching of subsequent space rockets.

Scientific Investigations, Study of Cosmic Rays.

One of the main tasks of scientific investigations, being carried out on the Soviet space is the study of cosmic rays.

Composition and properties of cosmic radiation at great distances from the earth are determined by the conditions, in which cosmic rays originate, and by the structure of the outer space. Upto now the information on cosmic rays was obtained by measuring cosmic rays in the vicinity of the earth. Whereas, as a result of the effect of a whole series processes, the composition and properties of cosmic radiation on the earth are sharply distinct from those, which are inherent to the "true" cosmic rays themselves. Cosmic rays observed on the earth's surface resemble very little those particles, which are incoming to us from the space.

With the use of high-altitude rockets and specially of earth satellites the path of cosmic rays from the outer space to receiver does not contain any more an appreciable quantity of matter. However, the earth is surrounded by magnetic field, which partially deflects the cosmic rays. On the other hand, the same magnetic field creates a unique trap for cosmic rays. Having once fallen into this trap, the particle of cosmic rays wanders there for a very long time. As a result a great number of cosmic ray particles gets accumulated in the vicinity of the earth.

As long as the instrument, measuring cosmic radiation, is within the activity sphere of the earth's magnetic field, the measuring results will not make it possible to study cosmic rays incoming from the universe. It is known fact, that among the particles, which are present at altitudes of about 1000 km, only a negligible part - about 0.1% - arrives directly from the cosmos. The remaining 99.9% of particles originate, apparently, from decay of neutrons, emitted by the earth (to be more exact, by the upper layers of atmosphere). These neutrons are in turn created by the cosmic rays, bombarding the earth.

Only when the receiver is beyond not only the earth's atmosphere, but also beyond the earth's magnetic field, will it be possible to elucidate the nature and the origin of cosmic rays.

The Soviet space rocket carries various instruments, which permit an all-round study of the composition of cosmic rays in the interplanetary space.

The intensity of cosmic radiation was determined by means of two charged-particles counters . The composition of cosmic rays was investigated by means of two photomultipliers with crystals.

The following was measured for this purpose:

1. Energy flux of cosmic radiation within a wide energy band.
2. Number of photons with energy above 50,000 electron-volt (hard X-rays).
3. Number of photons with energy above 500,000 electron-volt (gamma-rays).
4. Number of particles capable to pass through sodium-iodide crystal (the energy of these particles is above 5,000,000 electron-volts).
5. Total ionization, induced in the crystal by all types of radiation.

The countors of charged particles produced impulses in the special so called conversion circuits. By means of these circuits it is found possible to transmit by radio signal, when a certain number of particles has been counted.

Photomultipliers, connected to crystals, recorded light flash in crystals with the through passage of cosmic radiation particles. The intensity of impulse at the output of photomultiplier was proportional within certain limits to the amount of light, radiated at the instant of passage of the cosmic rays particle within the crystal. The amount of light in its turn is proportional to the energy consumed in the crystal for ionizing particles of cosmic rays. By separating impulses with intensity higher than a certain value, it is possible to investigate composition of cosmic rays. The most sensitive system records all cases, when the energy, separated in the crystal, exceeds 50,000 electron-volts. However, the penetrative capacity of particles with these energies is very low. In these conditions the recording will be mainly of X-rays.

The number of impulses is counted by means of the same conversion,circuits, as for counting the number of charged particles.

In the same way the separation is made of impulses, intensity of which corresponds to energy release in the crystal of over 500,000 electron-volt. In these conditions the recording is mainly of gamma-rays.

By separating impulses of even higher intensity (corresponding to energy release of over 5,000,000 electron volt) the instances are marked of the passage through crystal of cosmic ray particles, possessing high energy. It should be mentioned, that charged particles, included into composition of cosmic rays and moving practically with velocity of light, will pass through crystal. In this case the energy release in the crystal will be about 20,000,000 electron-volt.

Besides, the number measuring of impulses, determination is made of the total ionization, induced in the crystal by all types of radiations. This is done by means of a circuit, made up of neon lamp, capacitor and resistances. This circuit enables to determine by counting the number of neon lamp ignitions the total current flowing through the photomultiplier and thereby to measure the total ionization, build-up in the crystal.

Investigations conducted on the space rocket make it possible to determine composition of cosmic rays in the interplanetary space.

Gas Component Study of Interplanetary Matter and Corpuscular Radiation of the Sun.

Until recently it was assumed, that concentration of gas in the interplanetary space is very low and is measurable by particle units in a cubic centimeter. However, some astrophysical observations of the last few years have shaken this point of view.

The pressure of solar rays on particles of the topmost layers of earth's atmosphere builds up a unique "gas tail" of the earth, which is always directed away from the sun. Its luminescence, projected on the stellar background of the nightsky in the shape of antihalo, is known as the zodiacal light. In 1953 results were published of observing polarization of zodical light, which brought some scientists to conclusion, that interplanetary space in the area of earth contains about 600-1000 free electrons in a cu.cm. If this is so, and since the medium on the whole is electrically neutral, it should contain also positively charged particles in the same concentration. With certain assumptions the relation was deduced from the indicated polarization measurements of electronic concentration in the interplanetary medium and distance to the sun, and hence also of the density of gas, which has to be completely or almost completely ionized. The density of interplanetary gas should decrease with increasing distance to the sun.

Another fact, speaking for the existence of interplanetary gas with density of about 1000 particles in cu.cm, is the expansion of the so called "whistling atmospherics" - low-frequency electromagnetic oscillations, induced by the atmospheric electro-discharges. To explain the propagation of these electromagnetic oscillations from the point of their origin to the point, where they are observed, it has to be assumed, that they propagate along the lines of the earth's magnetic force, at distances of eight-ten earth radii (i.e. about 50-65 thous.km) from the earth surface, in medium with electronic concentration of about 1000 electrons in one cu.cm.

However, the conclusions as to the existence in the interplanetary space of such dense gas medium are by no means undisputable. Thus, a number of scientist point out, that the observed polarization of the zodiacal light could be caused not by the free electrons, but by the interplanetary dust. Assumptions are being expressed, that gas in the interplanetary space is present only in the form of the so called corpuscular flux, i.e. flux of ionized gas, ejected from the surface of the sun and moving at speed of 1000-3000 km/sec.

Apparently, in the present state of astrophysics the question of the nature and concentration of the interplanetary gas cannot be resolved by means of observations from the earth surface. This problem of enormous significance for elucidating gas exchange between the interplanetary space and upper layers of earth atmosphere and for the study of propagation conditions of the sun's corpuscular radiation, could be resolved by means of devices, set up on rockets, moving directly in the interplanetary space.

The object of setting up devices for studying gas component of interplanetary matter and corpuscular radiation of the sun on the Soviet space rocket is the carrying out of the first stage of these investigation - attempt of direct detection of stationary gas and corpuscular flux in the region of interplanetary space between the earth and the moon, and rough estimate of charged particles concentration in this region. In preparing the experiment on the basis of data-available at present the two following models of interplanetary gas medium were taken as the most probable:

A. Stationary gas medium, consiting mainly of ionized hydrogen (i.e. of electrons and protons - hydrogen nuclei) with electronic temperature 5000-10000^{o}K (approximating ionic temperature). Through this medium periodically passes corpuscular flux at velocity 1000-3000 km/sec. with concentration of particles - 1-10/cu.cm.

B. Only sporadic corpuscular flux, consiting of electrons and protons at velocities 1000-3000 km/sec, sometimes with maximum concentration of particles 1000/cu.cm.

The experiment is being conducted by means of proton traps. Each proton trap is a system of three concentrically arranged semispherical electrodes with radii 60, 22.5 and 20 mm. The two outer electrodes are made of fine metal net, the third is solid and serves as collector of protons. The electric potentials of electrodes in relation to container body are such, that electric fields, formed between the electrodes of the trap, should assure total gathering of all the protons and ejection of electrons, falling into the trap from the stationary gas, as well as suppression of photo-current from the collector, induced by the effect of ultraviolet radiation of the sun and other radiations affecting the collector.

Division of the proton current, built-up in the traps by the stationary ionized gas and corpuscular flux (if they exist jointly), is implemented by the simultaneous use of four proton traps, differing from each other in that the two of them have positive potential of 15 volts in respect of the container shell. This hindering potential prevents falling into the trap of protons from the stationary gas(having energy of about 1 electron-volt), but cannot prevent falling into collector of corpuscular flux protons of considerably higher energies. The other two traps should record the total proton currents, induced both by stationary and corpuscular protons. The outer grid of one of them is under the potential of container shell, and the other has a negative potential of 10 volts in relation to the same shell.

The currents in collector circuits are recorded after intensification by means of radio-telemetric system.

Investigation of Meteor Particles.

Besides, the planets and their satellites, asteroids and comets, the Solar System contains a large amount of fine hard particles, moving in relation to the earth and velocities from 12 to 72 km/sec and known in the complex as meteor matter.

At present, the main information on meteor matter, invading terrestrial atmosphere out of the interplanetary space, was obtained by astronomical, as well as radiolocation methods.

Comparatively large meteoric bodies, incoming at enormous velocity into earth atmosphere, get burnt within it, causing luminescence, observance visually and by means of telescopes. The finer particles are followed by radiolocators along the trace of charged particles - electrons and ions, formed with the movement of meteoric body.

On basis of these investigations data were obtained on the density of meteoric bodies in the vicinity of the earth, their velocity and mass from 10^{-4}g and higher.

Data regarding the fine and most numerous particles with diameter of a few microns are obtained from observing dispersion of solar light only on enormous accumulation of these particles. Investigation of individual micrometeoric particles is possible only by means of devices carried on artificial earth satellites, and also on high-altitude and space rockets.

The study of meteoric matter is of considerable significance for geophysics, astronomy, for resolving problems of evolution and origin of planetary systems.

In connection with the development of rocket technique and the beginning of the era of interplanetary flights, opened by the first Soviet space rocket, the study of meteoric matter acquires a high purely practical interest for determination of meteoric danger for space rockets and artificial earth satellites, being for a long time in flight.

Meteoric bodies on collision with the rocket can affect it in many ways: to destroy it, to disturb the tightness of the cabin by piercing the shell. Micrometeoric particles, by prolonged effect on the rocket shell, may change the nature of its surface. Surfaces of optics as a result of collision with micrometeoric bodies may get transformed from transparent into opaque.

As we know, the probability of space rocket collision with meteoric particles, capable of damaging it, is low, but it exists, and it is important to evaluate it correctly.

For investigating meteoric matter in the interplanetary space, the instrument container of the space rocket carries two ballistic piezoelectric pickups of ammonium phasphate, which record the impacts of meteoric particles. The piezoelectric pickups convert the mechanical energy of the incident particle into electric, the intensity of which depends on the mass and velocity of the incident particles, and the number of impulses is equal to the number of particles, colliding with the pickup surface.

The electric impulses from the pickup in the form of short-period attenuating oscillations are fed into input of amplifier-transformer, which divides them into three bands according to amplitude and estimates the number of impulses in each amplitude band.

Magnetic Measurements.

The achievements of the Soviet rocket technique open out to geophysicists extensive possibilities. Space rockets will permit to carry out direct magnetic fields measurements of planets by special magnetometers or to detect the planet fields due to their possible effect on the intensity of cosmic radiation directly in the space, surrounding the planet.

The flight of the Soviet space rocket with magnetometer toward the moon is the first of these experiments.

Besides the magnetic fields investigations of cosmic bodies, the question of magnetic fields intensity in the outer space, generally, has an enormous significance. The intensity of the earth's magnetic field at a distance of 60 terrestrial radii (at a distance of lunar orbit) is practically zero. There are grounds to assume, that the magnetic moment of the moon is low. The magnetic field of the moon, in the case of uniform magnetization, should decrease according to square cube law of distance from its center. With irregular magnetization the intensity of moon field will decrease even faster. Therefore, it can be reliably detected only in direct vicinity of the moon.

What is the intensity of the field within the orbital space of the moon at sufficient distance from the earth and the moon? Can it be determined by values, calculated from the magnetic potential of the earth, or does it depends also on other causes? The magnetic field of the earth was measured on the third Soviet satellite in the altitude range 230-1800 km, i.e. upto 1/3 of the earth's radius. Relative contribution of the possible non-magnetic part of the invariable magnetic field, effect of its variable part will be greater at a distance of several earth radii, where the intensity of its field is quite low. At a distance of five radii the earth field should be about 400 gammas (1 gamma = $= 10^{-5}$ oersteds).

The magnetometer on board the rocket, flying toward the moon, is meant for the following:

1. To measure the magnetic field of earth and possible fields of current systems within the orbital space of the moon.
2. To detect the magnetic field of the moon.

The question as to whether the planets of the Solar System and their satellites are magnetized similarly to the earth, is an important question of astronomy and geophysics.

Statistical processing of a great number of observations by magnetologists, implemented with a view of detecting magnetic fields of the planets and the moon from their possible effect on geometry of corpuscular flux, ejected by the sun, did not produce any definite results.

The attempt to fix a common bond between the mechanical moments of cosmic bodies, known for the majority of planets in the Solar System, and their possible magnetic moments was not confirmed by the whole series of ground experiments, which followed from this hypothesis.

At present the most frequently used in various origin hypotheses of magnetic field of the earth is the model of regular currents, flowing in the fluid conducting core of the earth and inducing the main magnetic field of the earth. The rotation of earth about the axis is used in this case for explaining particular characteristics of terrestrial field.

Thus, according to this hypothesis, the existence of the fluid conducting core is an obligatory condition for the presence of the general magnetic field.

The physical state of the internal layers of the moon is very little known. Until recently it was assumed, on basis of the surface view of the moon, that, even if the mountains lunar craters are of volcanic origin, the volcanic activity on the moon has ceased long ago and it is hardly likely, that the moon has a fluid core. With this point of view it should have been assumed, that the moon does not have magnetic field, if the hypothesis regarding origin of terrestrial magnetic field is correct. However, if the volcanic activity on the moon is continuing, the possibility is not excluded of the existence of irregular magnetization of the moon and even general uniform magnetization.

The sensitivity, measuring range of the magnetometer and the program of its performance were selected for the Soviet space rocket on basis of the need for resolving the above problems. Since the orientation of the measuring sensor in relation to the measured magnetic field continuously varies due to rotation of container and the earth, the use for experiment is of a three-component magnetometer of total vector with magnetically-saturated sensors. The three reciprocally perpendicular sensors of the magnetometer are rigidly fixed in relation to container body on a special non-magnetic rod over one meter in length. Even in this case the effect of magnetic parts of container apparatus composes 50-100 gammas, depending on the orientation of the sensor. Quite accurate results of measuring magnetic field of earth could be obtained upto distances of 4-5 times of its radius.

Research instruments aboard the rocket operated normally. A lot of recordings were obtained of measuring results, which are being processed. Tentative analysis shows, that the results of investigations are of high scientific value. These results will be published as the observations are processed.

The Artificial Sodium Comet and Apparatus for its Formation.

The artificial sodium comet is a cloud of sodium vapors in atomic state, which is ejected into space from the rocket at a certain instant. The luminescence of the sodium cloud is the result of resonance fluorescence. The principle of this phenomenon is that the sodium atoms disperse solar light in a narrow interval of frequencies in the yellow part of the solar spectrum.

The light, which is dispersed by the sodium cloud, is monochromatic, which makes it possible to attenuate to a considerable extent the sky background during the observation of the cloud through special light filters.

The brightness of the sodium cloud, containing 1 kg of sodium and formed at a distance of 113000 km from the earth, should according to estimation be equal to the sixth stellar magnitude, which corresponds to the ultimate possibility of observing the cloud with a naked eye. For comparison it should be pointed out, that the brightness of the space rocket itself in flight at this distance is equal approximately to the fourteenth stellar magnitude.

Therefore, the creation of the artificial sodium comet permits optical observation from the earth of a certain point on the path of the space rocket.

Observation of the sodium comet is only possible at night. This fact determines the time and the place of the sodium cloud formation with the flight of the space rocket. The time was chosen with an estimate of its visibility from the majority of stations in the Soviet Union.

Special devices were used to form the artificial sodium comet, carried on the last stage of the space rocket. The main unit in the set of devices is the sodium evaporator. The construction of the evaporator makes it possible to implement evaporation of 1 kg of sodium within 5-7 sec and ejection of the sodium cloud in conditions of weightlessness and deep vacuum of the outer space.

The command, required for the operation of evaporator at exactly determined moment, is given by a small-size electronic command device, the basis of which is the quartz clock.

The successful launching of the Soviet space rocket toward the moon and the creation of the first artificial planet is an outstanding achievement of the Soviet science and technique.

The time is not far off, when along the space ways, the start of which is initiated by the launching of the Soviet space rocket, interplanetary vehicles will be moving toward the most distant corners of the Solar System. The mankind has stepped into an epoch of direct penetration into the universe.

"Pravda", 12th January 1959.

TASS COMMUNIQUE ON THE LAUNCHING OF THE SECOND SPACE ROCKET TO THE MOON.

In accordance with the investigation program of the outer space and preparation for the interplanetary flights a second space rocket was successfully launched in the Soviet Union on the 12th September 1959.

The launching of the rocket is meant for investigation of the outer space during the flight to the moon.

The launching was accomplished by means of a multistage rocket.

The last stage, having exceeded the escape velocity - 11.2 km/sec, is moving toward the moon.

At 15 hours Moscow time on the 12th of September the Soviet space rocket has receded at 78.5 thousand km from the earth and was at that time above the point north of New Guinea.

The last stage of the space rocket is a controllable rocket weighing 1511 kg (without fuel). It carries a container with scientific and radio-technical instruments. The container in the shape of a sphere is air-tight and filled with gas. It has been provided with an automatic system for the control of heat conditions.

After insertion into orbit the container with the instruments was separated from the last rocket stage.

The following is to be accomplished by means of the second Soviet space rocket:

- magnetic fields investigation of the earth and the moon;
- investigation of radiation zones around the earth;
- intensity and its variations investigation of cosmic radiation;
- heavy nuclei investigation in cosmic radiation;
- gas component investigation of the interplanetary matter;
- meteoric particles investigation.

The total weight of testing and metering equipment with power supply and container composes 390.2 kg.

For transmitting to the earth of the whole scientific information, parameter measuring of the movement and flight control the rocket carries radiotransmitter, operating on two frequencies - 20.003 and 19.997 megacycles per second.

The transmitter emits signals in the form of telegraphic sendings with duration from 0.8 to 1.5 sec and operates in a way, that during breaks in radiation of the first 20.003 megacycles per second the impulses are transmitted on the second frequency - 19.997 megacycles per second.

There is another radio-transmitter, operating on frequencies 19.993 and 39.986 megacycles per second.

The transmitter's signals are impulses of variable duration from 0.2 to 0.8 seconds. The repetition frequency of impulses is 1 plus minus 0.15 cps.

The third radio-transmitter operates on frequency 183.6 megacycles per second.

The space rocket carries pennants with the emblem of the Union of Soviet Socialist Republics and inscription - September 1959.

For visual observation of the space rocket it carries special devices for creating sodium cloud - artificial comet. The sodium comet will be formed on the 12th of September at 21 hours 39 minutes 42 seconds Moscow time. It will be observed in the Aquarius constellation approximately on the line, connecting alpha stars of consetellations aquila and pisces.

The equatorial coordinates of the comet will be: direct ascension - 20 hours 41 minutes, declination - minus 7.2 degrees.

The artificial comet can be observed and photographed by optical means (with light filters separating spectral line of sodium) from the territory of Central Asia, Caucasus, Ukraine, Belorussia in the central part of the European territ[illegible] and also from Europe, Africa, Near East countries, India and Western China.

All the radio-transmitters on the space rocket operate normally. The ground radio stations are conducting reception of scientific information from abroad the rocket.

By means of special measuring automatic complex, the stations of which are located at various points of the Soviet Union, continuous parameter measuring is being conducted of the rocket's movement. The processing of measuring results and orbital elements determination is implemented on quick-acting computers.

Information regarding the movement of the space rocket will be transmitted by all radio stations of the Soviet Union.

According to tentative data, the rocket is moving along a path, close to calculated. It is expected that the space rocket will reach the moon on 14th September at 00 hours 05 minutes Moscow time.

The successful launching of the second Soviet space rocket is a new important step in the investigation and mastering of the outer space by a man. This extends the possibilities of International Cooperation in the sphere of mastering the outer space, which will contribute to further lessening of the International tension and strengthening of peace.

"Pravda", 13th September 1959.

TASS COMMUNIQUE PENNANTS OF THE SOVIET UNION - ON THE MOON.

Today, 14th September, at 00 hours, 02 minutues 24 second Moscow time the second Soviet space rocket reached the surface of the moon. For the first time in history space flight was accomplished from the earth to another celestial body. To mark this outstanding event pennants were brought to the moon with the emblem of Soviet Union and inscription: "Union of Soviet Socialist Republics. September, 1959".

To protect the pennants during the encounter with the moon, constructive measures were taken.

The program of research determinations has been completed.

Operation of radios, carried in container with research and metering instruments, has ceased at the moment of encounter with the moon.

Reaching of the moon by the Soviet space rocket is an outstanding success of the Soviet science and technique. A new page has been opened in the investigations of the outer space.

"Pravda", 14th September 1959.

The Scientists, Designers, Engineers, Technicians, Workers and all the participants in construction and launching of the second Soviet space rocket.

Central Committee of the Communist Party of the Soviet Union and the Council of Ministers of USSR warmly congratulate scientists, designers, engineers, technicians and workers, participating in construction and launching of the second Soviet space rocket to the moon.

Dear comrades ! By your creative and selfless labor you have once again demonstrated to the world the power of scientific and technical achievements of the country of Socialism. The launching of the second Soviet space rocket, which reached the surface of the moon on the 14th September, marks a new era in the mastering by mankind of the outer space; for the first time in history a flight has been accomplished from the earth to another celestial body.

We are convinced, that the new glorious victory of the Soviet science and technique will serve to strengthen the peace in the whole world, to develop friendly relations between people of every nation.

Glory to the Soviet scientists, designers, engineers, technicians and workers, glorifying by their labor our Great Socialist Motherland, progressing under the wise leadership of Lenin's Party to new victories in the building of communism!

Central Committee of the CPSU | Council of Ministers USSR

"Pravda", 15th September 1959.

TASS COMMUNICATION ON THE FIRST ARRIVAL OF THE [illegible] OF SPACE ROCKET TO THE MOON.

The Soviet space rocket, started on the 12th September 1959, has reached surface of the moon on the 14th September at 00 hours 02 minutes 24 seconds Moscow time.

Fig.7. Pennant brought to the moon by the second space rocket.

The flight of the Soviet multistage space rocket to the moon went exactly along the marked calculated path. All the systems, units and elements of the rocket operated normally during the flight.

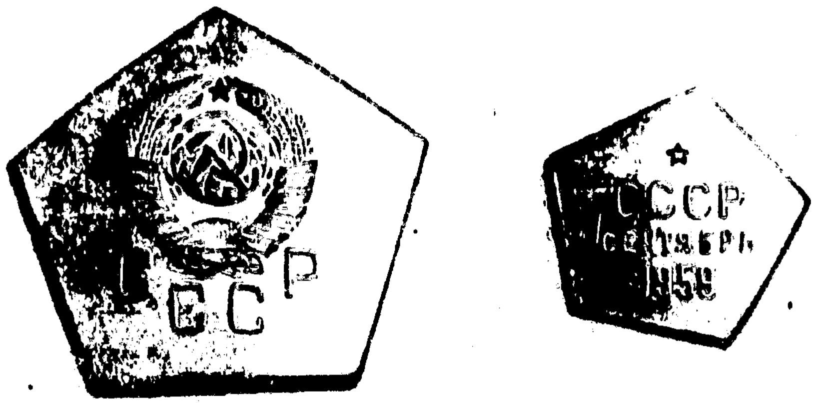

Fig.8. Pentagonal elements of the spherical banner.

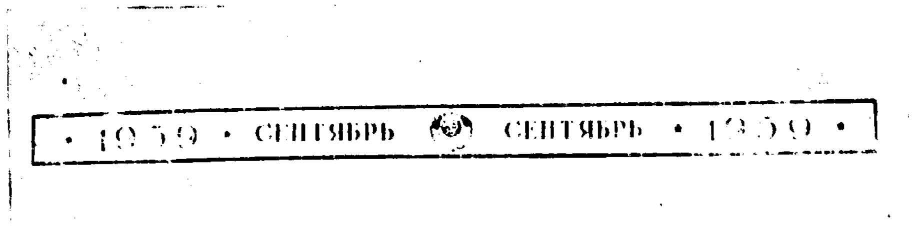

Fig.9. Tape-pennant.

Radio-technical means, carried on board the rocket, assured reliable following from the earth of its flight, beginning from the start until the moment, when container with the instruments reached the surface of the moon.

Successful work of the automatic measuring complex on the ground permitted continuous control conformity of the actual flight path with calculated data, to forecast correctly getting to the moon and to determine the area of landing.

Analysis of the actual movement path of the second Soviet space rocket on basis of recorded data of all types of measurements and observations permits to carry out at present the first verification of the landing area of container with instruments and the last stage of the rocket. Data processing of observations shows, that the container landed on the moon's surface east of the Mare Serenitatis in the vicinity of craters Aristillus, Archimedes and Autolycus. The selenographic latitude of the encounter point of container with the surface of the moon, according to obtained data, is plus 30 degrees, and the selenographic longitude is zero. Deviation of the landing point of container from the center of the visible moon discis approximately 800 km.

At the moment of container's encounter with the moon its path was inclined to the surface of the moon at an angle of 60°. The velocity of container in relation to the moon was about 3.3 km/sec.

The obtained data processing confirms, that the last stage of the space rocket has also reached the moon.

As has been communicated, during the flight of the second Soviet space rocket to the moon the following investigations were to be carried out: magnetic fields of the earth and the moon radiation zones around the earth, intensity of cosmic radiation, of heavy nuclei in cosmic radiation, of gas component in the interplanetary matter, meteoric particles.

Analysis of material, obtained as a result of these investigations, confirmed, that the instruments in container operated normally. Initial interpretation has been carried out of the telemetering.

The obtained tentative data permit even now to fix the following:

- the magnetic field in the vicinity of the moon, according to magnetometer recordings, within the sensitivity limits and deviation error (about 60 gamma), was not detected;
- intensity measurements of radiation in the vicinity of the moon detected no radiation zone of charged particles. This fact is concordant with results of magnetic measurements;
- measurements were conducted in the outer space along the path of rocket of the total flux of cosmic radiation, flux of helium nuclei (alpha-particles), nuclei of carbon, nitrogen, oxygen and heavier nuclei in the composition of cosmic rays;

- additional data were obtained on X-rays, gamma-rays, electrons of high and low energies and high-energy particles;
- measurements were conducted within the radiation zone of the earth;
- recording was made of currents, induced by particles of ionized gas, falling from the surrounding medium into the four set up on container traps of positively charged particles. The intensities of recorded currents vary along the path of the rocket; tentative estimates show, that there are regions between the earth and the moon, where concentration of ionized particles is less, than a hundred in a cubic centimeter. In nearing the moon at a distance of about ten thousand km the recorded currents become of higher intensity. This could be explained either by the existence around the moon of ionized gases blanket - a unique lunar ionosphere, or by the presence around the moon of a region of higher concentration of corpuscles with energies of some tens of volts;
- new data were obtained on micrometers.

Further processing and analysis is being carried out of the obtained data.

On completion of this work the results of carried out investigations will be published.

The construction of multistage space rocket, engines, flight control system and a complex of ground stations, which have assured the exact start and high-precision movement of the rocket to the moon, as well as reliable control of the rocket's flight till the moment of encounter with the moon, is an outstanding success of the Soviet science and technique.

The launching of the second Soviet space rocket, complex of investigations carried out and the reaching of moon surface will make a considerable contribution to the world science, into the mastering of the outer space by a man.

"Pravda", 21st. September 1959.

THE FIRST FLIGHT TO THE MOON.

An exciting communication flew around the world about the launching in the Soviet Union of the second space rocket, which has reached successfully the moon's surface on the 14th September at 00 hours, 02 minutes 24 seconds. For the first time in the history of mankind a flight was accomplished from the earth to another celestial body.

The accomplishment of the flight from the earth to the moon was made possible by the high level of science and technique development in the Soviet Union. It is the results of the effort of the Soviet scientists, designers, engineers, technicians and workers, the result of inspired labor of the numerous staff, participating in construction and launching of the second Soviet space rocket. The launching of a rocket to the moon is a very composite scientific and technical problem.

For the flight to the moon it was necessary to construct a most perfect multistage rocket, powerful rocket engines, operating on high-calory fuel, high-precision flight control system of the rocket, ground starting equipment and automatic metering complex to follow the rocket's flight.

In order to imagine the demands for accuracy of rocket flight control, in start automatics, of measuring job for resolving the launching problem of rocket to the moon, we give some information regarding movement of the moon, and certain questions, related to selection of the flight path.

Let's recall the main characteristics of the moon's movement, known from astronomy. The moon, being a satellite of the earth, moves around the earth along an orbit, almost circular. The orbital inclination of the moon at present is about 18°. Because of this the orbital declination of the moon, i.e. the angle composed by the line from the center of the earth to the moon with terrestrial equator plane, varies from + 18° to minus 18°. The orbital period of the moon around the earth is about 27.3 days. Distance of the moon from the earth composes on an average 384,386 km and varies from 356,400 km at perigee to 406,670 km at apogee. The orbital velocity of the moon is approximately 1 km/sec. At this velocity the moon describes during 24 hours an arc in celestial sphere of about 13 degrees.

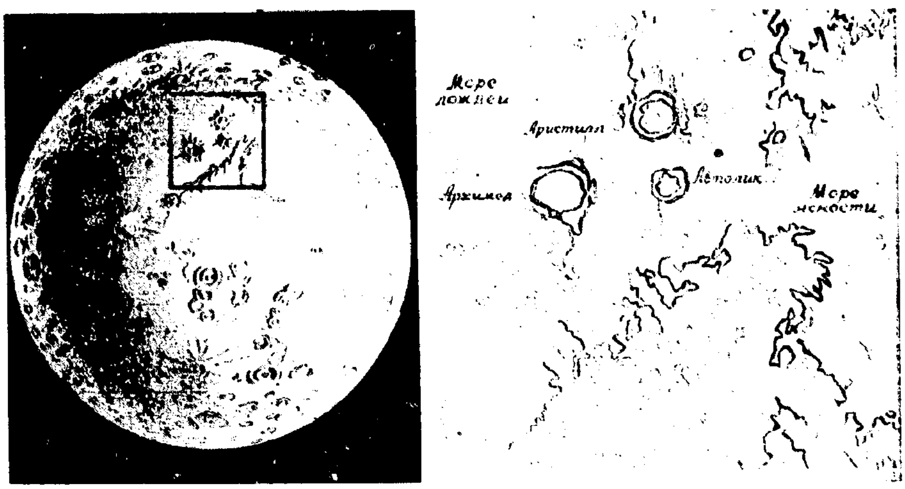

Fig.10. The impact area of the second space rocket with the moon. Direct image.

1- Mare Imbrium; 2- Mare Serenitatis; 3- Aristillus crater; 4- Archimedes crater; 5- autolycus crater.

The flight path of the rocket to the moon consists of two parts: acceleration region, where under the effect of engine impulse the rocket is brought out into a certain space point picking up the required velocity, and the free flight region, which begins after the engine cutoff of the last stage of the rocket and separation of container. The separation of container from the last rocket stage takes place due to their mechanical disconnection and imparting to container certain additional velocity.

According to the laws of celestial mechanics, the free flight trajectory after the engine cutoff in its major part, where the moon's attraction is comparatively low, was similar to hyperbola, with one of the foci in the center of the earth.

With increasing distance from the earth the velocity gradually decreased to about 2 km/sec. Hence due to progressively increasing effect of the moon's attraction velocity decrement has ceased. The velocity begun increasing and continued to rise till the moment of impact with the moon's surface. The velocity of impact with the moon was upto 3.3 km/sec.

The launching of rocket to the moon was preceded by theoretical investigations and technical calculations, which enabled to determine the trajectory parameters and the starting time, providing for reaching the moon in the most suitable conditions. Let's discuss it in more detail.

In principle the launching of rocket for reaching the moon is possible any day, i.e. at any position of the moon in its orbiting around the earth. However, the estimates show, that the launching of the rocket from points of terrestrial surface at latitudes of the Soviet union is energetically suitable, when the moon is close to the point of its minimum orbital declination, i.e. when the moon's declination is close to -18°. In this case the rocket in the acceleration area will move at lowest angle to terrestrial surface and velocity loss due to earth's attraction will be minimum, which assures the possibility of sending to the moon of the highest effective load. With the start at a later or earlier period the weight of the possible effective load decreases. However, with the shift of a few days this loss is comparatively low, and during each lunar month there is an interval of about a week, during which the flight to the moon will be expedient. With a more considerable deviation from the optimum period the possible effective weight becomes sharply reduced.

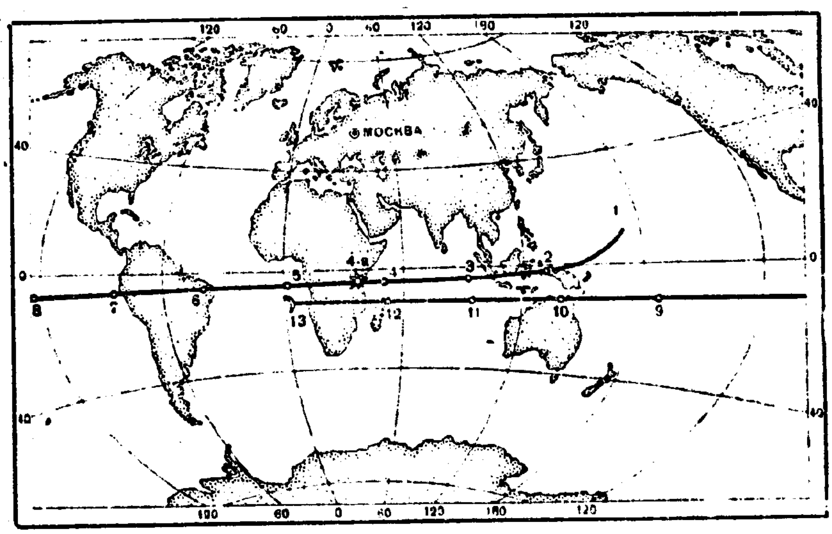

Fig.11. Course diagram of the second space rocket. The figures on the diagram correspond to successive positions.of the rockets projection on earth surface.

1- 12 hrs, 12th September; 2- 15 hrs, 78500 km from the earth; 3- 18 hrs, 112000 km; 4- 21 hrs, 142000 km; 4a- formation of artificial comet; 5- 00 hrs, 13th September, 171000 km; 6- 3 hrs, 198000 km; 7- 6 hrs, 224000 km; 8- 9 hrs, 250000 km; 9- 12 hrs, 274000 km; 10- 15 hrs, 298000 km; 11- 18 hrs, 322000 km; 12- 21 hrs, 346000 km; 13- 00 hrs, 02 min. 24 sec, 14th September 371000 km, impact point with the moon.

Within the indicated interval during the impact of rocket with the moon the moon should be above the horizon. In the flight of space rocket the impact time was selected so, that the convergence with the moon should occur during the period, when for the observation points the moon is close to the point of the upper culmination, i.e. its height above the horizon is almost maximum. In this case the conditions of radio-communication are the most favorable.

As a result of calculations the selection was of the most beneficial inclination of trajectory plane, which determined for the preset start point the course of the rocket's flight in the initial section. With different directions of the course inclination of the rocket's velocity in the acceleration section and the loss to attraction force of the earth differ. The course was selected with an estimate of minimum loss and hence, of a maximum possible effective weight. The questions were also considered of convenient arrangement of the set of instruments for the flight control and obtaining of telemetric information both in the acceleration area and in the initial area of free flight after the engine cutoff of the last stage.

Calculations have shown, that in flight to the moon from the territory of the Soviet Union the moon at the moment of start should be beyond the horizon close to the point of the lower culmination. This means, that the moment of start should differ from the moment of the upper culmination of the moon by about 12 hours. If it is taken into account, that at the instant of reaching the moon it should be at the point of the upper culmination, it becomes clear, that the flight to the moon should continue either for 12 or 36 hours, or two and a half days, etc.

For the flight of the space rocket the duration was selected of about one and a half days, since the flight of half a day requires extremely high starting speed, and the flight of two and a half and more days on condition of impact with the moon and assured observation of it at the moment of impact involves the necessity to satisfy much more stiff requirements of the accuracy in maintaining the flight parameters at the end of the acceleration area.

The choice of the flight duration has determined the velocity of rocket at the termination of the acceleration area, which, as mentioned above, was slightly higher than parabolic.

Calculations of the rocket's path both in the acceleration area and in the free-flight section were carried out by means of quick-acting digital computers. The attraction forces of the earth and the moon were taken into account in calculations. It was also found to be necessary to take into account deviation of the earth's gravity field from the central due to compression of the earth and disturbing effect of the sun's attraction.

To obtain during the flight of the rocket parameters of movement at the end of the acceleration section, adequately coinciding with their calculated values, the rocket carried a control system, which was operating througout the extent of the acceleration section, duration of whic lasted several minutes. The further one and a half day's flight of the rocket was non-controlable and was only due to the effect of the earth's gravity field, the moon and other celestial bodies.

To assure the impact of the rocket with the moon in the absence of any corre ion of its movement in the free-light section the calculated movement parameters at the end of acceleration section should be very precise. Thus, error in the rocket's velocity only of one meter per second, i.e. by 0.01% of the total velocity, results in deviation of the impact point with the moon by250 km. Deviation of velocity vector from the calculated direction by one angular minute causes displacement of the impact point by 200 km. Considerable effect on the position of the impact point of rocket with the moon has also change in coordinates of the engine cutoff point. All the listed errors, as well as the inaccurate start time of the rocket have a combined effect, determining, invariably. greater deviation of the impact point with the moon, thar de iation due to each factor individually.

Considering, that the moon's radius is 1740 km, for reliable impact with he moo the erro in velocity should not be over a few meter per second, and de.i tion of velocity vector from the calculated direction not over one tenth of a degree. To provide this accuracy in the control of the rocket is a very difficult problem.

It should be mentioned, that accomplishment of the flight to the moon from the territory of the Soviet Union requires more exact accuracy in the performance of control system, that the flight from areas of the Globe nearer to equator.

The need to maintain the exact calculated time of the start is bound with the fact, that the projectory plane of the rocket turns jointly with the earth in its daily rotation about the axis. Deviation of the starting time by 10 seconds causes displacement of the impact point on the surface of the moon by 200 km. The start of cosmic rocket at preset moment with accuracy of upto a few seconds requires considerable effort in organizing and preparing the start and proper functioning of the automatic launching system. The launching of the second Soviet space rocket, accomplished with high accuracy, indicates perfection of the starting system and high reliability of the starting automatics.

The start of the second space rocket was accomplished with deviation of about one second from the fixed moment.

In the problem of the space rocket flight most important were the questions of building up metering and calculating service of a composite complex, meant for quick determination of the movement characteristics of space rocket.

The specific requirement, determining the complexity of the measuring system as a whole, is the requirement of as quick as possible obtaining of data on the movement characteristics of the rocket. These data are necessary for calculating target designation to observing and measuring services to estimate the forecast on the rocket's movement and on the impact point with the moon's surface.

As shown by the above data, which characterize the effect of errors in movement parameters on position of the impact point, determination of these parameters from the measuring data should be done with very high accuracy, corresponding to accuracy of astronomical calculations.

The usual methods for determination of movement characteristics of cosmic bodies, developed by many-years astronomical practice, cannot be used for the above purpose. Actually, the basis of observing astronomy - optical measurements - are unsuitable due to the small size of rocket as an object of observation, due to low accuracy of some angular measurements with the limited observation time and, finally, due to low reliability of these measurements, dependent to a considerable extent on conditions of visibility and the state of earth atmosphere. Therefore, the measuring job of the space rockets is based on radio-technical means of measuring. In this case the measurements used are of oblique distances, angles and radial velocities.

These specifics and requirements for determination of the space rocket movement parameters are fully estimated in the automatic measuring complex. This complex permits to measure the current oblique distance to rocket with high precision and two angles per rocket: azimuth and place angle. Measurements data, obtained at the measuring point, are converted into binary code, pre-processed and tied to astronomical time. All above operations are being carried out by special digital file computers. The same file computers provide for automatic issue of measured data in communication line both in conditions of measuring and in conditions of memorized information issue. The incoming information is automatically decoded in computing center by means of special electronic devices and punched on cards, which are hence put into electronic computers. From measuring data, incoming from various measuring stations, the computers carry out calculations of the intial movements of rocket, target destination and coordinates of the impact point with the moon.

In order to obtain the most complete data of the space rocket movement within the whole flight area upto the moon continuous measurements were conducted of distance to the rocket, its radial velocity (velocity of withdrawal from the measuring point) and angular coordinates: place angle and azimuth. The measurements were on frequency 183.6 megacycles per second.

Data of scientific observations, conducted on board the space rocket, and information on working conditions of the instruments (pressure and temperature) were transmitted and recorded by the ground telemetric stations. Scientific data were transmitted by means of radio-transmitters, operating on frequencies 183.6, 39.986 and 19.993 megacycles per second.

The flight of the rocket's last stage was observed through transmitter, operating on two frequencies: 19.997 and 20.003 megacycles per second. Additional scientific information about the intensity of cosmic radiation from device on the last stage of the rocket were transmitted along the same radio-channel.

Thus, in the observation of the second Soviet space rocket a large complex was participating of radio-technical stations, located at special measuring points in various parts of the Soviet Union. All the measuring points were joined by a special communication system, providing for quick transmission of data into computing center and target destination to measuring points.

For coordination of the measuring points in time and tying of results to single time the use was of specially created for this purpose time service.

Tentative processing of measuring data, which came after 20-30 minutes from all the measuring stations of the Soviet Union along the automatic communication lines into computing center, made it possible within the first hour of the space rocket flight to estimate the path of its further movement, to verify, that it was placed quite correctly for the impact with the moon, to estimate target designation for subsequent measurements and observations both to Soviet and foreign measuring stations. From these data it was determined, that the assumed impact point is in the northern part of the moon's visible disc.

The subsequent more accurate processing of these data with additional information on distance measuring and radial velocity of the rocket made it possible to confirm the place and the time of the impact with the moon. It was fixed, that the impact point lies in the area of Mare Serenitatis 800 km from the center of the visible moon disc.

The successful flight of the second Soviet space rocket to the moon is an important step in the investigations of the outer space and celestial bodies.

"Pravda", 21st September 1959.

TASS COMMUNICATION ON THE LAUNCHING OF THE THIRD SPACE ROCKET TO THE MOON.

In accordance with the program for investigation of the outer space and preparation for interplanetary flights a third successful launching of a space rocket was accomplished in the Soviet Union on 4th October 1959. The rocket carried an interplanetary station.

The launching was implemented by means of a multistage rocket. The last stage of the rocket, having picked up the preset velocity, inserted the automatic interplanetary station into required orbit.

The orbit of this station was selected with an estimate of its passing in the vicinity of the moon and around it.

The automatic interplanetary station will pass the moon at a distance of about 10 thousand km and, and rounding the moon, will pass in its further movement in the area of the earth. The selected orbit makes it possible to observe the station from the northern hemisphere of earth.

The last stage of the third Soviet space rocket weighs 1553 kg (without fuel).

The interplanetary station was carried on the last stage of the rocket. After insertion into orbit the station was separated from the rocket. The last stage of the rocket moves along an orbit, close to that of the station. The automatic interplanetary station is designed for extensive investigations in the outer space. Set up aboard the station are the research and radio-technical devices, as well as an automatic system for thermal control. Power supply of devices on board is provided by solar batteries and chemical current sources. Total weight of the station is 278.5 kg. Moreover, the last stage of the rocket carries measuring instruments with power supply sources weighing 156.5 kg. Thus, the total weight of effective load composes 435 kg.

Scientific information and measuring results of the movement parameters of the automatic interplanetary station will be transmitted by two radio-transmitters on frequencies 39.986 and 183.6 megacycles per second. The orbital elements of the interplanetary station will be controlled at the same time on radio-line with frequency 183.6 megacycles per second.

Signals of transmitter on frequency 39.986 megacycles per second are impulses of variable duration from 0.2 to 0.8 sec. The repetition frequency of impulses is 1 ± 0.15 cps.

Information transmission from aboard the automatic interplanetary station will take place in periods of 2-4 hours daily, in accordance with the observation program. Operation of devices on board the interplanetary station is controlled from the earth, from the coordination-computing center.

The rocket's parameters are measured by the automatic measuring complex, ground stations of which are located at various points of the Soviet Union.

Transmissions on the movement of the third space rocket will be carried on by every radio-station in the Soviet Union.

The routine working period of the radio-stations will begin on the 4th October at 13 hours Moscow time. At this time the rocket will be above a point in the Indian Ocean with coordinates 80° east longitude, 5° south latitude at 108 thousand km above the earth. The working period of the radio-stations will continue for about 2 hours.

Radio observations of the rocket could be conducted from Europe, Asia, Africa and Australia.

The launching of the third Soviet space rocket and construction of the automatic interplanetary station will make it possible to obtain new data on the outer space and will be further contribution of the Soviet People in the International Cooperation on mastering the cosmos.

"Pravda", 5th October, 1959.

TASS COMMUNIQUE ON THE MOVEMENT OF THE THIRD SOVIET SPACE ROCKET ("LUNA-3").

In accordance with the planned program of investigations on 7th October at 6 hours 30 minutes Moscow time the apparatus was switched-on aboard the interplanetary station for obtaining an image of invisible from the earth part of the moon and subsequent transmission of this image to earth.

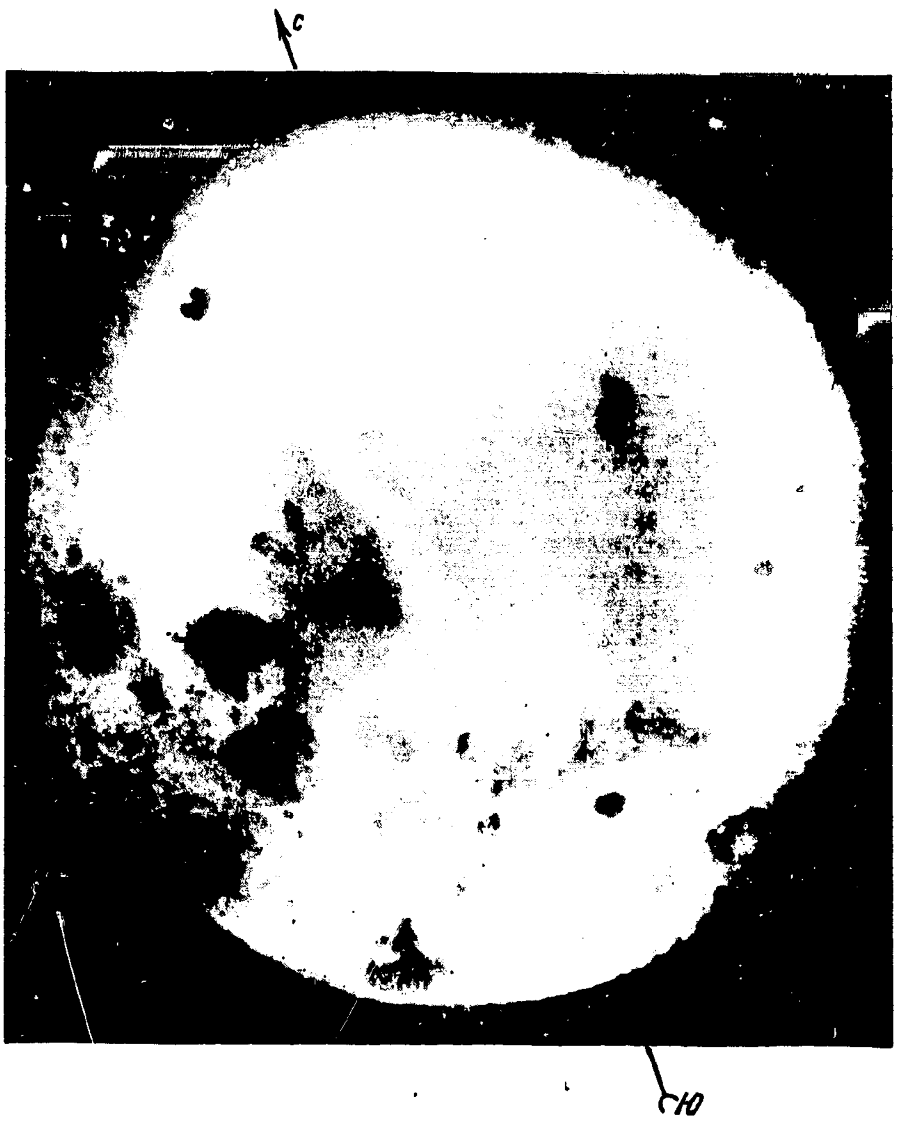

Fig.12. Photograph of the other side of the moon.

To photograph the moon the automatic interplanetary station is equipped with orientation system and photo-television camer with special arrangement for the automatic processing of the film.

The time of photographing was selected with an estimate for the orbiting station to be between the moon and the sun, which illuminated about 70% of the invisible side of the moon. The station then was at a distance of 60-70 thousand km from the moon's surface.

Orientation system cut-in by a special command turned the station in a way for the objectives of the photocamera to be directed at the other side of the moon and gave the command for the switch on of the photo-camera.

The moon was photographed for about 40 minutes and a considerable number of the moon's pictures was obtained on two different scales.

Developing and fixing of films were done automatically aboard the interplanetary station.

Signals of the photoimage of the moon were transmitted to earth by means of special radio-technical system. This system provided simultaneously data transmission of scientific measurements, orbital elements determination, and transmission from the earth to the interplanetary station commands, controlling its operation. Television camera transmitted half-tone image with high resolving power.

The first shots of the invisible part of the moon, obtained as a result of tentative processing, will be published in the newspapers of 27th October with necessary descriptions and subsequently - in science editions.

A commission has been set up by the Academy of Sciences USSR to name the craters, ranges and other features of the invisible part of the moon.

Instruments were arranged on board the automatic interplanetary station for investigations in the interplanetary space. The obtained results were recorded on film by the ground stations and are at present being processed.

The performance of the automatic interplanetary station during the first revolution has shown, that:

the flight of cosmic object along a composite pre-calculated orbit is successfully assured orientation problem of the object in space has been resolved;

radiotelemechanical communication and transmission of TV pictures at cosmic distances has been accomplished;

The image has been obtained of the other side of the moon and a number of other results.

At 20 hours on the 27th of October the interplanetary station will be above the point of terrestrial surface with coordinates 38° 6' west longitude and 6° 30' north latitude at 484 km from the earth's center.

Verification of the orbital characteristics of the interplanetary station shows, that it will exist from the moment of start for about half a year and will accomplish 11-12 revolutions around the earth. At the end of this period the interplanetary station will enter into dense layers of the earth's atmosphere and will get burnt.

"Pravda", 27th October 1959.

THE THIRD SOVIET SPACE ROCKET.

On the 4th October 1959 a successful launching was accomplished in the Soviet Union of a third space rocket. The object of the launching was the resolution of a number of problems in connection with the outer space investigations. The most important of these was the obtaining of the photographic picture of the moon's surface. Of special scientific interest was to obtain photograph of the part of the surface, which due to peculiar movement of the moon is quite unattainable for terrestrial observers, as well as a part of the surface, visible from the earth and such low angles, that it cannot be authentically studied.

For detailed investigation of the outer space and obtaining photographic picture of the moon an automatic interplanetary station was constructed, which by means of a multistage rocket was placed into orbit around the moon. Exactly according to calculations the automatic interplanetary station passed at a distance of several thousand km from the moon and due to its attraction hanged direction of the course, which made it possible to obtain flight path, convenient both for the photographing of invisible from the earth side of the moon and for transmission to the earth of the obtained information.

The launching of the third space rocket and insertion into preset orbit of the automatic interplanetary station required resolution of a number of new, very difficult scientific and technical problems. The multistage rocket, used for insertion of the station into orbit, was of high constructive perfection with powerful engines, working on high-energy fuel. Control system of the rocket during the acceleration period made it possible to obtain the preset parameters of flight with high accuracy.

Scientific investigations by means of the automati interplanetary station provided considerable amount of material, which is at present being processed. Photographs, obtained from the other side of the moon, are of enormous scientific interest. For the first time in history it was possible to take a look at the part of the moon's surface, never observed from the earth.

The launching of the automatic interplanetary station indicates high level in development of our science and technique.

The Arrangement of the Automatic Interplanetary Station.

The automatic interplanetary station is a space vehicle equipped with a composite set of radio-technical, photo-television and scientific apparatus, special orientation system, program devices for controlling performance of the apparatus, automatic control system of the thermal conditions within the station and power-supply sources.

The special radio-technical system measures orbital parameters of the station, transmits to the earth television and scientific telemetering information and commands from the earth for the performance control of apparatus on board of the interplanetary station.

The orientation system assured orientation of the interplanetary station in the space relative to the sun and moon, required for the photographing of the invisible side of the moon.

Operation of the station's apparatus is controlled from the ground stations along a radio-line, as well as by independent program devices on board. This type of combined system makes it possible to control most conveniently the scientific experiments and to obtain information from any sections of the orbit within the limits of radio-visibility from the ground observation stations.

The thermal control system continuously maintains within the station the preset heat conditions. It provides for elimination of heat, given-off by devices, through a special radiation surface into surrounding space. To control heat output louvers are fixed on the outside of the body, opening the radiation surface with the rise of temperature inside the station upto +25°C.

The power-supply system contains independent blocks of chemical current sources, providing power to short-action devices, and a central block of chemical buffer battery. Energy consumption of buffer battery is compensated by solar sources of current. The apparatus is energized through transformers and stabilizers.

The set of scientific instruments aboard the automatic interplanetary station provides for further development in the investigation of cosmic and circumlunar space, begun on the first two Soviet space rockets.

The automatic interplanetary station is a thin-walled air-tight construction of cylindrical shape with spherical bottoms. Maximum diameter of the station is 1200 mm, length - 1300 mm (without the antennas). Arranged on a frame inside the body are the instruments and chemical power sources. Arranged outside is a part of the scientific instruments, antennas and sections of solar battery. The top bottom has an illuminator with cover, automatically opening prior to photographing. There are small illuminators at the top and bottom sides for the solar sensors of the orientation system. The control engines of the orientation system are arranged on the lower bottom.

Taken as the most expedient arrangement to photograph the moon was the sighting of the photo-camera by a turn of the whole interplanetary station. The orientation system aboard the station turned and maintained the interplanetary station in a required position.

The orientation system was cut-in after the approach to the moon, at a moment, when the station was in the preset position in relation to the moon and the sun, assuring the required conditions for orientation and photographing. Distance to the moon in this case in accordance with calculation is 60-70 thousand km.

At the start of work the orientation system, which includes optical and hydroscopic sensors, logical electronic devices and control motors, first of all stoped the arbitrary rotation of the interplanetary station about its gravity center, originated at the moment of separation from the last stage of the carrier-rocket.

The automatic interplanetary station is illumined by three bright celestial bodies - the sun, the moon, and the earth. Its flight path was selected in a way, that at the moment of the shot the station would be approximately on a straight line, connecting the sun and the moon. In this case the earth should be offside from the sun-moon line, to prevent orientation on the earth instead of to the moon.

This position of the interplanetary station in relation to celestial luminaries at the starting moment of orientation enabled to use the following method: initially its lower bottom by means of solar sensors was directed at the sun: thereby the optical axes of the photo-camera were directed into opposite side - at the moon. Thereafter the appropriate optical device, in the vision field of which the earth and the sun could not appear anymore, cut-off orientation to the sun and set an exact orientation on the moon. The signal incoming from the optical devices of the "presence" of the moon permitted photographing. During the whole period of photographing the orientation system continuously guided the interplanetary station on the moon.

After the exposure of all the frames the orientation system was cut-off. At the cut-off moment the system imparted to the automating interplanetary station an ordered rotation with angular velocity, chosen so, as to improve, on one hand, the thermal conditions, and on the other - to exclude the effect of rotation on the functioning of scientific instruments.

<u>The Flight of Interplanetary Station.</u>

The orbit of the automatic interplanetary station was specially adapted for resolving the assigned complex of scientific problems. To obtain the required orbit, besides providing the necess ,' velocity and the course of the station at the mo .t of the engine cutoff of the last stage, the effect was also used of the moon's attraction.

The path around the moon had to meet a number of requirements. To ensure the correct performance of the orientation system during photographing it was necessary, as mentioned above, that at the starting moment of orientation the moon, station and the sun would be on approximately on one straight line. Distance from the station to the moon during the period of photographing was taken about 60-70 thousand km.

The nature of the path should have allowed to obtain maximum amount of information at the first turn and specially at low distances from the earth. To implement this requirement it was necessary to ensure the best possible conditions of radio-communication with the interplanetary station from the ground points on the territory of the Soviet Union.

It was also most desirable to obtain for scientific investigations a flight path, providing for the movement of interplanetary station in space of a sufficiently prolonged period.

The flight around the moon with return to earth may be accomplished along a path of various types. To obtain these paths the velocity at the end of acceleration flight should be somewhat lower than the so called escape or parabolic velocity, which on the earth's surface composes 11.2 km/sec. If the flight path passes at a distance of some tens of thousands km from the moon its effect is comparatively low and the movement in relation to earth will be along a path, similar to ellipse with focus in the center of the earth.

However, the path of a distant flight around the moon passing it at some tens of thousands km has quite a number of most essential drawbacks. With the flight at great distances from the moon the direct investigation of the outer space in the immediate vicinity of the moon becomes impossible. With the launching of the rocket from the northern hemisphere of the earth the return to earth takes place from the side of the southern hemisphere, which makes it difficult to conduct observations and reception of scientific information by the stations in the northern hemisphere. The movement in the vicinity of the earth during the return is beyond the limits of visibility from the northern hemisphere, and hence the reception in the vicinity of the earth of information regarding the results of investigations becomes impossible. On return to the earth the rocket enters the dense atmospheric layers and gets burnt, i.e. the flight ends after one rotation.

These short-comings could be avoided, if another type of path is used during the flight around the moon, which will pass just at a few thousands km from the moon.

The flight path of the automatic interplanetary station passed at 7900 km from the center of the moon and was selected with an estimate for the station to be south of the moon at the moment of the maximum approach. Due to the moon's attraction the path of the automatic station in accordance with calculations deflected northward. This deviation was so considerable, that the return to the earth took place from the side of the northern hemisphere. Moreover, after the approach to the moon maximum height of the station above the horizon for the observation points in the northern hemisphere increased from day to day. There was a corresponding increment of periods, during which direct communication was possible with the automatic station. With sufficient approach to the earth the automatic station could be observed in the northern hemisphere as a sustained luminary.

The conditions for information reception on approach to the earth and conditions for scientific investigations in the area to immediate vicinity of the earth were quite good. On return to earth at the first revolution the station did not enter into atmosphere and did no perish, but passed at 47500 km from the center of the earth, moving along an extended elliptical orbit of very large dimensions. Maximum withdrawal of the station from the earth composed 480 thousand km.

Thus, with passage close to the moon it is possible to obtain flight paths of the automatic interplanetary station most interesting and beneficial from the viewpoint of scientific investigations and reception of scientific information.

The flight of interplanetary station in the vicinity of the earth takes place at such great distances from its surface, that there is no atmospheric brake drag. Therefore, if the movement was due only to attraction force of the earth, the automatic station would have been an earth's satellite with unlimited period of existence.

Whereas, in reality the time of the station's movement is limited. Due to disturbing effect of the sun's attraction the nearest orbital distance from the earth - the perigee - gradually decreases. Therefore, after a certain number of revolutions, the station with one of its returns to the earth will enter into dense atmospheric layers and will get burned.

The decrease in the altitude of perigee during one orbital period depends on dimensions of the orbit and specially on the altitude of apogee, i.e. on the maximum distance of orbit from the earth, sharply increasing with increased altitude of apogee. Therefore, in selecting the path of the interplanetary station it was necessary to obtain the altitude of apogee as low as possible and not much exceeding distance from the earth to the moon. It was also necessary to get the altitude of perigee on the first revolution as high as possible. The extent of meeting these requirements will determine the total number of the station's rotations around the earth and its time of existence.

The effect of the moon is not limited to that, which it exerts during the periods of the first close approach. Disturbances of the station's orbit from attraction of the moon are not of such regular nature, as disturbance of the sun, and depend to a great extent on the orbital period of the station around the earth. The effect of the moon could be quite appreciable, if at some of the subsequent revolutions there is a repeated close approach to the moon. In this case the approach of the station to the moon would have taken place approximately at the same point of the lunar orbit, as the first time. In the case of repeated close approach the nature of the station's movement may change considerably. If the interplanetary station will pass close to the moon from the south side, i.e. the second approach will be of the same type, as the first, the number of revolutions and the existence time of the station will sharply increase with maintenance of the basic property of its path - approach to the earth from the side of the northern hemisphere. If the repeated passage will be from the side of the horth, the perigee altitude of the orbit will decrease and in the case of quite a strong disturbance there may occur a collision with the earth in the very next return.

On those orbital loops, where there is no close approach to the moon, the moon nevertheless exerts some effect on the orbiting of the station. Although the attraction force of the moon in this case is very low, however, by affecting considerable number of the path's loops, the moon's attraction has a considerable effect on the orbiting of the automatic station, causing decrease in the altitude of perigee and reducing the orbital existence time of the station.

The orbiting pattern of the automatic interplanetary station under the effect of the simultaneously acting gravity forces of the earth, the moon and the sun are most complex. The nature of the passage close to the moon in the first approach determines further orbiting of the interplanetary station.

Since the movement of the interplanetary station is not corrected on the way and the whole of its flight is determined in final count by the orbital parameters at the end of acceleration period (mainly by the velocity attidude), it is clear, that the realization of the above described space station path is only possible with extremely perfect control system of the carrier-rocket in the area of acceleration.

Calculations,show, that with deviation from the point of station's passage through the pattern plane by a thousand km the minimum distance between the earth and the station in its return will vary by 5-10 thousand km, and the time of the maximum approach to the earth - by 10-14 hours. The picture plane in this case is the plane, passing through the center of the moon perpendicularly to the earth-moon line.

In order to get the ultimate deviation of the minimum distance between the earth and the station not exceeding

20 thousand km, the control accuracy in the area of the orbital insertion of the rocket should be such, as to assure deviation of the intersection point of the picture plane not over 3000 km. At first sight this condition, demanded of rocket's control system, seems easier in comparison with conditions, dictated by the impact problem with the moon, since to assure the impact ultimate deviation of the rocket from the target point, or calculated point of passing the picture plane, should not exceed the moon's radius, i.e. should be approximately half of the 3000 km. However, in the case of the station's orbiting the moon, errors in the orbital insertion of the rocket affect deviation of the picture plane intersection point to a considerably greater extent, than for the impact version, implemented by the second space rocket.

Actually, as communicated, velocity deviation in placing the rocket into free flight area by one meter per second in the impact version with the moon results in deviation of the picture plane intersection point by 250 km, and in the case of launching for orbiting the moon this deviation will compose 750 km, i.e. three times that. Only from comparison of these figures it is clear, that realization of the preset version of orbiting path requires even higher accuracy of the rocket control system, than in the impact version.

As has been mentioned, with the passage of interplanetary station in the vicinity of the moon the station's path experiences intensive disturbance, which forces to change the initial course of the orbiting, stipulating station's return to the earth from the side of the northern hemisphere. The same disturbing effect of the moon intensifies effect of the movement parameters deviation at the end of acceleration area from their calculated values on the nature of the station's movement on its return to the earth after orbiting the moon. Therefore, even small errors in determination of these parameters result in very considerable errors in calculating movement characteristics of the interplanetary station in its return to the earth.

At the same time for reliable radio-communication of the interplanetary station with the ground observation points requires an accurate knowledge of the time variation of the station's orbiting characteristics. This is necessary for precise estimation of target designation for the measuring points and to determine moments for the cut-in of transmitters on board. This fact requires continuous path measuring of the interplanetary station, data processing and verification of the orbiting characteristics of the station.

The described circumstances present critical demands to performance of the automatic measuring complex, meant for the measuring of the station's orbital parameters, forecasting its movement, estimate of target indication for the measuring and observing stations, time calculation for the cut-in of transmitters on board the interplanetary station during the whole flight around the earth.

This complex includes radio-technical stations of measuring distance, angular parameters and radial velocity of the object, reception stations of telemetric information, automatic communication lines of measuring points with coordination and computing center, which in turn is connected with the ground stations, giving the command for the switching off of transmitter aboard the automatic interplanetary station.

The command radio-line makes it possible to cut-in the radio-technical means of the station at certain intervals, corresponding to best conditions of radio-communication of the board apparatus with ground stations on the territory of the Soviet Union. Selection of duration and time for cutting-in radio-communication with the station is done on condition of sufficient accumulation of information needed for verifying characteristics and forecasting the course of the interplanetary station, and also on condition of maintaining power balance of the instruments on board.

Tentative results processing of the path measuring has shown, that the automatic interplanetary station will be orbiting till April 1960 and will complete 11-12 revolutions around the earth.

Photographing and Transmission of Pictures.

In developing the set of devices for takeing and transmitting pictures of the invisible side of the moon from the automatic interplanetary station the problem was successfully resolved of constructing photo-television system for obtaining good-quality half-tone pictures and transmitting them at distances, measured by hundreds of thousands of km. This also helped to resolve a number of composite scientific and technical problems.

During the photographing the orientation system provided position of the automatic station, when the lunar disc was in the vision field of objectives.

The construction of the photo-television camera assured its working in the difficult conditions of the space flight; safety was assured of the photo-material against the adverse effect of cosmic radiations and the normal performance of the photo-processing block and other blocks of instruments in conditions of weightlessness.

For the super-distant transmission of pictures at very low power of radio-transmitter the application was of the picture-transmission velocity tens of times lower, than the transmission velocity of the ordinary broadcasting TV centers.

With the first shot of the other side of the moon it was expedient to photograph as large as possible area of its unknown surface. This necessitated complete photographing of illumed disc, the contrast of which is always considerably lower than with a side illuminance, creating shadows from the topographic details. For a better transmission of the low-contrast picture an automatic brightness adjustment was used in the photo-TV apparatusof the transmission tube.

For reliable non-adjustment operation of the set of instruments in variable conditions principles were applied of self-adjusting circuits. Coordination and control of performance of all the units, including electronic circuits, optical, mechanical and photo-chemical devices, were implemented by a special automatics and programming system.

The photo-TV apparatus, carried on the interplanetary station, contains the following main equipment, Photo-camera with two objectives of focusing distance 200 and 500 mm, by means of which simultaneous shots were made in two different scales. Objective with the focusing distance 200 mm produced a picture of complete disc. The large-scale picture, produced by the objective with focusing distance 500 mm, was beyond the limits of the photo and showed a more detailed picture of the part of the lunar disc.

The photos were taken with automatic change of exposure for obtaining negatives with best densities and the taking continued for about 40 minutes, and during this time multiple pictures were taken of the other side of the moon.

The photographing begun on command signal, after the objectives were sighted on the moon. The whole subsequent process of shooting and film processing was automatic in accordance with preset program. The pictures were taken on a special 35-mm film, meant for developing at high temperature.

To prevent film fog under the effect of cosmic radiation a special protection was provided, chosen on basis of investigations, conducted by means of Soviet artificial satellites and space rockets.

At the end of shooting the film was fed into a small sizd device of automatic processing, where it was developed and fixed.

A special process was used for developing, providing for a low dependence of the negative parameters on temperature. Necessary measures were taken to prevent disturbance of processing in conditions of weightlessness. After development the film was dried and the moisture absorbed, which assured a long-term safety of the film. At the end of development the film was fed into a special cassette and prepared for the transmission of the picture.

Pre-exposed on the film were test signs, a part of which was developed on the earth, and the other part developed aboard the station during development of the pictures, taken of the other side of the moon. These signs were transmitted to the earth and made it possible to control the shooting, development and transmission of the pictures.

To convert the picture on negative film into electric signals the use was of electron-ray transmitting tubes of high resolving power and high-stability photo-electric multiplier.

The transmission of pictures to the earth was accomplished in the same way, as in transmission of cinefilms to TV centers.

Economical low-frequency scanning devices were used for deflecting the ray of the electronic-ray tube. Amplification and formation of picture signals was accomplished by a specially developed narrow-band stabilized amplifier with automatic compensation for the variation effect of negative's density on the output signal. All the circuits were mostly on semiconductors.

Picture transmission was arranged in two conditions: slow transmission at great distances and fast at shorter distance on approaching the earth.

Depending on transmission conditions the TV system made it possible to change the number of lines, into which the picture disintegrated. Maximum number of lines was upto 1000 per one exposure.

The transmitting and receiving scanning devices were synchronized by a method, which assured high anti-interference stability and reliable performance of the apparatus.

Pictures of the moon were transmitted from the automatic interplanetary station along the radio-communication line, which served at the same time for measuring orbital parameters of the station itself, namely: distance, velocity and angular coordinates, as well as for transmission of scientific experiment results by means of telemetry. Switch on and off of various devices aboard the station and change in their working conditions was by the transmission from earth of special commands along the same radio-line.

Transmission of the moon's pictures and all other functions in radio-communication line with the station were implemented by continuous emission of radio-waves (in contrast to impulse emission, used previously in some cases). This combination of functions in a single line of radio-communication with continuous emission has been executed for the first time and made it possible to assure a reliable radio-communication upto maximum distances at a minimum energy consumption on board.

The line of radio-communication with the station consisted of two parts: earth-station line and station-earth line and included command receivers, powerful transmitters, highly-sensitive receivers and recorders, antenna,systems at ground points of radio-communication, as well as transmitters, receivers and antennas, carried on the interplanetary station. Besides, the station carried command receivers and program radio-technical devices.

The Whole apparatus of the radio-communication line both aboard and at ground points was duplicated to enhance reliability of communication. In the case of failure of one of the radio-technical devices on board or depletion of its performance resources it could be replaced by the reserve device by giving appropriate command from the ground control center.

The moon's pictures were transmitted on commands from the earth. These commands switched on power supply of the TV set on board, drawing of film and cut-in of the TV set to transmitters on board. As a result brightness variation was transmitted to earth along the lines, into which the picture decomposes.

The total volume of scientific information, transmitted along the radio-communication line including pictures of the moon, greatly exceeded the volume of information, transmitted from the first and second Soviet space rockets. For reliable transmission of this information in the presence of considerable noise level of cosmic radiation a specially effective method was applied of radio-communication, assuring minimum consumption of energy from the power supply sources on board.

For economizing electric energy power of transmitters on board was fixed at few watts. In receiving and transmitting radio-set on board the use was of semiconductors and other modern details and material, special attention was paid to obtaining minimum volume and weight of devices.

Difficulties, connected with providing reliable radio-communication with the interplanetary automatic station can be imagined, if it is estimated, what portion of power, emitted by radio-transmitter on board, comes into ground receiver.

To avoid break-down of radio-communication with the station on its return, the station's antennas emit radio-signals uniformly in all directions, so that the power of emission per unit of surface will be similar for all the points of imagined sphere, at the center of which is the station.

The receiving antenna on the ground gets a part of the emission power, determinable by the ratio of receiving antenna effective area to the surface of sphere with radius, equal to distance from the station to receiving point. Therefore, for reception of signals from the station the receiving antennas are very large.

However, even in this case with maximum withdrawal of the station from the earth the receivable part of the emission power from transmitters on board is 100 million times lower, than the average power, received by the ordinary TV receiver. The reception of these weak signals requires highly-sensitive receivers with low level of output noise.

The noises at the output of ground receiver are made up of cosmic radio-emission noises, received by the antenna, and natural noises of receiver, which were reduced to a minimum by a number of special measures. Decrease in the level of noise, as a rule, is bound with reduction in the rate of information transmission.

Due to above stated the application in the radio-communication line was of methods for processing and transmission of signals aboard the station and at ground receiving center, at which the noise level is reduced to a maximum extent with retention of admissible rate of transmission.

Economics use of power sources aboard the station, presence of radio-communication line with continuous emission and combined functions, application on earth of special reception antennas, high sensitivity of receivers, special methods for processing and transmission of signals - all this enabled to assure reliable radio-communication with the automatic interplanetary station, unfailing action of command radio-line and systematic taking of the moon's pictures and telemetric scientific information.

Signals of TV picture, received by the ground reception center, were recorded by various devices, which assured the necessary reserves and made it possible to monitor the transmission and to eliminate the specific distortions, caused by the specificities of the radio-communication line and recorders.

Signal fixing of the moon's picture was on special recorders of TV pictures on the film, on magnetic recorders with high stability in the travel speed of the tape, on sciatrones and on devices of open recording of the picture on electro chemical paper. Material, obtained from all types of recording, is used in the study of the invisible side of the moon.

By means of a TV system, set up on board of the interplanetary automatic station, the transmission of pictures was accomplished at distances of upto 470 thousand km. Thereby the possibility was confirmed experimentally of transmitting in the outer space at super-distances of half-tone pictures of high clarity without any appreciable specific distortions in the porpagation process of radio-waves.

The Invisible Side of the Moon.

The period of the moon's revolution about its axis coincides with period of its revolution around the earth, and therefore the moon is always turned to the earth with the same side. In distant past, millions of years ago, the moon revolved about its axis faster, than now, completing one revolution during a few hours.

Forces of tidal friction, induced by the attraction of the sun and the earth, decelerated the moon, by prolonging the period of its revolution about the axis, and made it 27.32 days.

Until now the maps could be composed only for the visible from the earth region of the moon, telescopic study of which is continuing for the past 3½ centuries. Denoted on these maps are circular mountains, mountain ranged, dark areas of lunar soil, called Mares, and other formations.

Visible from the earth is not exactly half of the lunar sphere surface, but somewhat more than half, namely 59%. In this part of the moon many formations are right at the edge of the visible disc and hence could not be studied in detail due to high perspective distortions. The fact, that slightly more than half the disc could be studied from the earth, is explained by the presence of the so called libration of the moon, i.e. by the swaying of the moon for terrestrial observer.

Pictures of the moon from aboard the interplanetary space station were taken at the moment when the station was on the line, connecting the sun and the moon, i.e. when the moon for it was a fully illumed disc. On photograph the boundary between the visible and unvisible sides of the moon is shown by a dotted lines.

Obtained on the photographs was a part of the invisible from the earth surface of the moon and a small region with already known formations. Presence of this region on the photos made it possible to tie the never previously observed objects of the lunar surface to the known and, in this way, to determine their selenographic coordinates.

Among the objects, photographed from aboard the interplanetary station and visible from the earth are the Mare Humboldtianum, Mare Crisium, Mare Marginis, Mare Symthii, part of the Mare Australe, etc.

These seas, lying right on the edge of the moon still visible from the earth, seem to us due to perspective distortion as narrow and long, and their actual form was until now undetermined. On photographs, taken from the interplanetary station these seas lie far from the visible edge of the moon, and their shape is very little distorted by the perspective. Thus, for the first time it wasppossible to see the actual shape of a number of lunar formation.

It is noticeable, that on the available photos of the invisible part of the lunar surface the predominance is of hilly areas, whereas the seas, similar to those on the visible part, are very few. Clearly defined are the crater maria, lying in the southern and equatorial regions.

Out of the maria, located close to the edge of the visible part in extreme foreshortening, clearly distinct in pictures almost without distortion are the Mare Humboldtianum, Mare Marginis, Mare Smythii and Mare Australe. It was found, that considerable part of the Mare Australe is on the other side of the moon, moreover its boundaries are of irregular sinuous shape.

Mare Smythii has a more round shape in comparison to Mare Australe, and a hilly region is deeply entrenched into its southern side. The Mare Marginic is slightly extended northward, and in the opposite to Mare Crisium direction has a depression.

The Mare Humboldtianum is of a unique pear shape. The whole region, adjacent to the western edge of the other side of the moon (i.e. to Mare Marginis), has an intermediate reflective capacity between the hilly regions and maria. In reflective capacity it is similar to the region of the moon between the craters Tycho, Petavius and Mare Nectaris.

SSE from the Mare Humboldtianum on bourdary of the above region is a mountain range with total extent over 2000 km, passing through equator and extending into southern hemisphere. Beyond the hill range extends a wide continent with high reflective capacity.

In the region between 20° and 30° N and 140° and 160° W lies a crater sea about 300 km in diameter. In the southern part the crater terminates in a bay. In the southern hemisphere, in area with coordinates -30° latitude and + 130° longitude is a large crater over 100 km in diameter with a dark bottom and a bright central hummock, surrounded by a light-color wide swell.

East of the above range, in area +30° N, is a group of four craters of medium size, the largest of which has a diameter of about 70 km. South-west of this group, in area with coordinates +10° latitude and +110° longitude, is an individual crater of round shape. In the southern hemisphere at the western edge are two regions with sharply reduced reflective capacity.

Moreover, the photographs show individual regions with slighly higher and lower reflective capacities and numerous fine details. It will be possible to fix, the nature of these details, their shape and size, after an intensive study of all the photos.

The fact, that for the first time it was possible to transmit a TV picture of the invisible side of the moon from aboard the interplanetary station, opens out the widest possible prospects for the study of planets in our Solar System.

The flight of the third space rocket has opened a new page in the history of science. Penetrating into outer space the Soviet rockets will be sending now to the earth not only the information regarding physical characteristics of the interplanetary medium and celestial luminaries, but also pictures of celestial bodies, past which they are flying. For the first time TV transmission was accomplished of pictures from distances of hundreds of thousand km. The widest possibilities are opened out for astronomy, which now can bring its instruments close to celestial bodies.

The first Soviet automatic interplanetary station makes every Soviet citizen pround of our great Socialist Motherland, of advanced Soviet science and technique. It causes admiration of all progressive mankind.

"Pravda", 27th October 1959.

THEIR NAMES HAVE BEEN IMMORTALIZED.

A conference took place recently of the Presidium Commission of the Academy of Sciences USSR on suggestions for naming the newly-discovered formations on the other side of the moon. During the scientific study of the photographs, obtained of the other side of the moon a number of new formations were fixed, which have to be named. The commission has found it possible even at the present stage of studies to confer on the craters and cirques the names of outstanding scientists: Jordano Bruno, Jules Verne, Hertz, Kurchatov, Lobachevskii, Maxwell, Mendeleev, Pasteur, Popov, Sklodovskaya-Curie, Tsu Chiun-Chi and Edison.

The Presidium of the Academy of Sciences USSR has confirmed the suggestion.

The minutes of Commission will be forwarded to International Astronomical Society.

Jordano Bruno (1548-1600) - great Italian philospher, materialist and atheist, daring critic of scholastics, fighter for science.

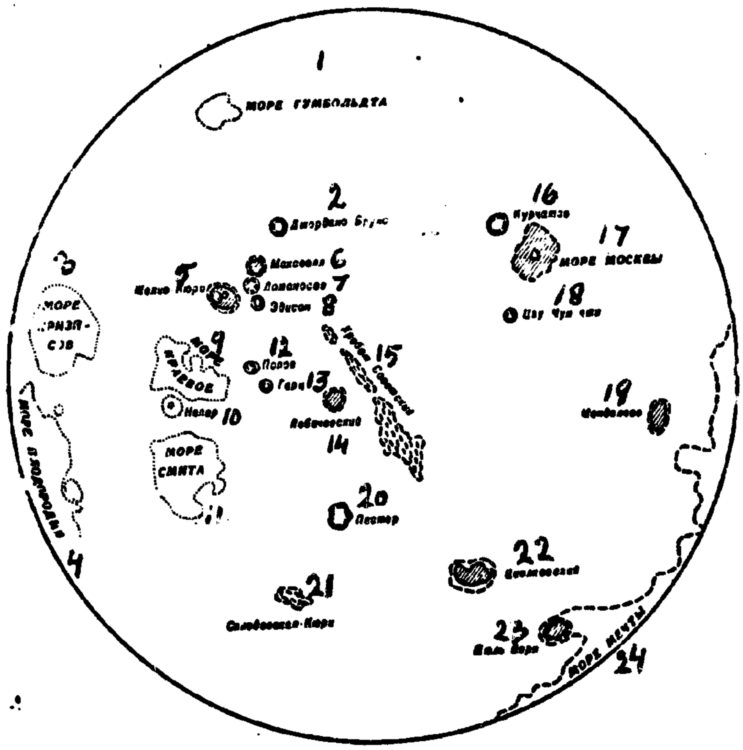

Fig.13. Naming of the newly discovered formation on the other side of the moon (formations surrounded by dots are visible from the earth).

1- Mare Humboldtinum; 2- Jordano Bruno; 3- Mare Crisium; 4- Mare Foecunditatis; 5- Julio Curie, 6- Maxwell; 7- Lomonosov; 8- Edison; 9- Mare Marginis; 10- Naler; 11- Mare Smythii; 12- Popov; 13- Hertz; 14- Lobachevskii; 15- Sovetskii Range; 16- Kurchatov; 17- Mare of Moscow; 18- Tsu Chun Chi; 19- Mendeleev; 20- Pasteur; 21- Skladovskaye-Curie; 22- Tsiolkovskii; 23- Jules Verne; 24- Mare of Dream.

Jules Verne (1828-1905) - outstanding French writer, author of widely-known science-fiction books.

Hertz, Henrich Rudolf (1857-1894) - famous German physccist.

Kurchatov, Igor Vasil'evich (1903-1960) - one of the most outstanding physicists-scientists of our times. Greatest specialist on nuclear physics.

Lobachevskiy, Nikolai Ivanovich (1792-1856) - great Russian methematician, creator of the non-Euclidean geometry.

Maxwell, James Clark (1831-1879) - famous English physicist. One of the greatest physicists theoreticians of the XIX century.

Mendeleev, Dmitriy Ivanovich (1834-1907) - great Russian scientist-chemist. Discovered periodic law of chemical elements, which is a naturally-scientific basis of the modern science of substance.

Pasteur, Luis (1922-1895) - great French scientists, who initiated development of microbiology as an independent science.

Popov, Aleksandr Stepanovich (1859-1906) - famous Russian scientist, inventor of radio.

Sklodovskaya-Curie, Maria (1867-1934) - Polish in nationality, worked in France. Became famous by discovering radioactive elements (radium and polonium), which was the initial point of all contemporary nuclear physics and chemistry

Tsu Chun-Chi - famous Chinese mathematician and astronomist, who lived in the V century.

Edison, Thomas Alva (1847-1931) - famous American electro-technician, inventor.

"Pravda", 18th March 1960.

TASS COMMUNIQUE "LUNA-4" IN FLIGHT.

In accordance with investigation program of the outer space and planets of the Solar System a space rocket toward the moon was launched in the Soviet Union on 2nd April 1963.

The last stage of the rocket was initially placed into intermediate orbit of the artificial earth satellite, then started and came out on precalculated orbit.

The space rocket carries an automatic station "Luna-4" weighing 1422 kg. "Luna-4" will reach area of the moon after three and a half days.

All the instrumentation aboard the automatic station operates normally.

Tracking of the station, parameter determination of its path, reception on the earth of scientific information are being carried out by a special measuring complex on the territory of the Soviet Union.

According to results, processed upto now, the trajectory of the automatic ~~station is close~~ to calculated.

At 16 hours Moscow time on the 2nd April 1963 the station was 50,486 km from the earth above a point of terrestrial surface with coordinates 122 degrees 37 minutes S and 38 degrees 56 minutes N.

"Pravda", 3rd April 1963.

<u>TASS COMMUNIQUE ON ORBITING OF "LUNA-4".</u>

At 4 hours 24 minutes on the 6th April the automatic station "Luna-4" passed above the surface of the moon at 8500 km.

Experiments and measurements conducted by means of "Luna-4" are completed. Radio-communication with the station will continue for a few days.

An extensive experimental material has been obtained, which is of great significance for resolving a number of technical problems, connected with the conquest of the moon. The measurements data are being processed and studied in the science center of the country, conducting investigations of the outer space.

In its further flight during 1963 the "Luna-4" will be revolving around the earth on extended orbit. Maximum withdrawal of the station from the earth on the first revolution will be about 700 thousand km, minimum - about 90 thousand km. Due to attraction of the sun and the moon the orbit of "Luna-4" will eventually be considerably disturbed. As a result the station will be beyond the sphere of terrestrial attraction and will become an artificial satellite of the sun.

This concludes the TASS communique on the orbiting of "Luna-4".

"Pravda", 7th April 1963.

TASS COMMUNI UE "LUNA-5" IN FLIGHT.

In accordance with the program for investigations of the outer space and planets of the Solar System a space rocket was launched in the Soviet Union on the 9th of May 1965 toward the moon.

The space rocket carries automatic station "Luna-5" weighing 1476 kg, equipped with instruments for scientific investigations.

The launching was accomplished by means of a multistage rocket. The last stage was initially placed into intermediate orbit of the artificial earth satellite, thereafter in accordance with preprogramming placed the automatic station onto prescribed lunar trajectory.

The cut-in of telemetric, measuring and scientific instruments is automatic, in accordance with the flight program, as well as on commands from the earth, Flight observation of "Luna-5", orbital parameters determination, reception on earth of scientific information are being conducted by a special measuring complex. The trajectory of "Luna-5" is close to calculated.

At 22 hours Moscow time on the 9th of May 1965 the "Luna-5" was 110 thousand km from the earth above a point of terrestrial surface with coordinates 41°10' E and 13°34' N. All the instruments aboard the automatic station "Luna-5" are operating normally. The coordination and computing center is conducting processing of all the incoming information.

"Pravda". 10th May 1965.

TASS COMMUNIQUE ON THE TERMINATION OF "LUNA-5" FLIGHT.

On the 12th of May 1965 at 22 hours 10 minutes Moscow time the automatic station "Luna-5" has reached surface of the moon in the area of Mare Nubium.

During the flight and on the approach of the station to the moon an enormous volume was obtained of information, required for further development of a system for soft landing on the surface of the moon.

"Pravda", 13th May 1965.

TASS COMMUNIQUE "LUNA-6" IN ORBIT.

In accordance with the program for investigations of the outer space and planets of the Solar System a space rocket was launched on the lunar trajectory on the 8th of June 1965 from the Soviet Union.

The space rocket carries automatic station "Luna-6" weighing 1442 kg, equipped with measuring and scientific instruments. The launching was accomplished by means of a multistage rocket. The last stage was initially placed into intermediate orbit of the artificial earth satellite, and then in accordance with preprogramming placed the automatic station on the prescribed lunar trajectory.

With prescribed trajectory the flight of the automatic station to the moon will continue for about three and a half days. The telemetric, measuring and scientific instruments are cut-in automatically in accordance with the flight program and on radio-commands from the earth.

Tracking of the automatic station "Luna-6", parameters determination of its trajectory, reception on the earth of scientific information is conducted by a special measuring complex. The trajectory of the automatic station "Luna-6" is close to prescribed.

At 13 hours Moscow time on the 8th of June 1965 the station "Luna-6" was at a distance of 21 thousand km from the earth above a point on terrestrial surface with coordinates 160°21' E and 36°53' N.

All the instruments aboard the automatic station "Luna-6" operate normally. The coordination-computing center is conducting processing of all the incoming information.

"Pravda", 9th June 1965.

TASS COMMUNIQUE ON THE FLIGHT OF AUTOMATIC STATION "LUNA-6"

During 8-9th June 1965 there were 12 periods of radio-communication with the automatic station "Luna-6", in the process of which on commands from the earth the station systems were controlled, the trajectory measured and telemetric information was received.

During this time experiments were conducted on the operation of a number of the station's systems. The obtained data have shown, that the radio-control trajectory, radio-control and independent control systems assure normal performance of the station. It was fixed, that astro-orientation systems have made it possible to carry out all the required maneuvring of the station. The measurements have shown, that the flight path is within the limits of prescribed deviations.

At the end of the day on the 9th of June 1965 during the trajectory correction of "Luna-6" the station's systems accomplished normal orientation, starting and operating of motor. However, the command for the cutoff of the engine was not fulfilled, and as a result the flight path of the station deviated from prescribed.

The station will pass the moon at 160 thousand km.

Radio-communication with the station is steady. Testing of the station's systems and the scientific experiments continue.

"Pravda", 11th June 1965.

TASS COMMUNIQUE "LUNA-7" IN FLIGHT.

In accordance with the program for investigations of outer space and planets of the Solar System a space rocket was launched in the Soviet Union on 4th October 1965 into a lunar trajectory.

The space rocket carries automatic station "Luna-7" weighing 1506 kg, equipped with measuring instruments for scientific investigations.

The launching was accomplished by means of a multistage rocket. The last stage of the rocket was initially placed into intermediate orbit of the artificial earth satellite, thereafter in accordance with preset program placed the automatic station into lunar trajectory.

The cut-in of telemetric, measuring and scientific instruments is automatic in accordance with the flight program and on radio-commands from the earth.

The tracking of the automatic station "Luna-7", trajectory parameters determination, reception on earth of the scientific information is conducted by a special measuring complex. The trajectory of the automatic station "Luna-7" is close to prescribed.

At 17 hours Moscow time on the 4th of October 1965 the station "Luna-7" was at a distance of 67,300 km from the earth above a point of terrestrial surface with coordinates 113°2 E and 13°20' N. All instruments aboard the automatic station "Luna-7" operate normally. The coordination-computing center is conducting processing of all the incoming information.

"Pravda", 5th October 1965.

TASS COMMUNIQUE ON FLIGHT COMPLETION OF "LUNA-7".

The automatic station "Luna-7" has reached the moon's surface on the 8th of October at 1 hour 08 minutes 24 seconds Moscow time in the area of Oceanus Procellarum, west of Kepler crater.

After correction, carried out on the 5th of October, the majority of operations, required for the soft landing, were implemented in the approach to the moon.

Some operations were not fulfilled in accordance with the program and required additional finishing.

During the flight of the automatic station "Luna-7" a lot of practical data were obtained for further work.

"Pravda", 9th October 1965.

TASS COMMUNIQUE "LUNA-8" IN SPACE.

On the 3rd of December 1965 launching was accomplished in the Soviet Union of automatic station "Luna-8".

The main designation of the station is further perfecting of the elements in the system for soft landing on the moon and scientific investigations.

The station weighs 1552 kg. It carries scientific, telemetric and other measuring instruments, which are cut-in automatically in accordance with the flight program and on commands from the earth.

Preliminary results of measuring processing show, that the station's trajectory is close to prescribed. All the instruments aboard the station operate normally.

Sergei Pavlovich Korolev.
1906 - 1966

The tracking of the flight is carried on by a special measuring complex.

The coordination and computing center processes all the incoming information.

At 18 hours Moscow time on the 3rd of December 1965 the station "Luna-8" was at 45,670 km from the earth above a point on terrestrial surface with coordinates 41°19' N and 83°21' E.

"Pravda", 4th December 1965.

TASS COMMUNIQUE ON COMPLETION OF FLIGHT BY STATION "LUNA-8".

On 7th December 1965 at 00 hours 51 minutes 30 seconds Moscow time automatic station "Luna-8" reached surface of the moon at a point with coordinates 9°8' N and 63°18' E.

On the station's approach to the moon composite checking was conducted of the operation of systems for soft landing. The checking has shown normal operation of the station's systems at all the stages of the lunar landing, except the final. As a result of "Luna-8" flight further step has been made to accomplish soft landing.

"Pravda", 8th December 1965.

FROM THE CENTRAL COMMITTEE OF THE CPSU
AND THE COUNCIL OF MINISTERS USSR.

The Central Committee of the CPSU and the Council of Ministers USSR inform with deep regret, that on the 14th of January 1966 at the 60-th year of life suddenly expired the greatest scientist and designer in the sphere of the rocket technique and space investigations Academician Korolev Sergei Pavlovich, member of the Presidium of the Academy of Sciences USSR, member of the CPSU, twice Hero of Socialistic Labor, laureate of Lenin premium.

Central Committee of CPSU Council of Ministers USSR.

"Pravda", 16th January 1966.

ADDRESS OF COMRADE KELDYSH M.V. AT A MOURNING MEETING.

Comrades !

Unexpected loss of a remarkable son of our people, the greatest scientist and designer in the sphere of the rocket technique and investigations of outer space, Academiciam Korolev Sergei Pavlovich fills our hearts with great sorrow.

Our country and the whole world science have lost a scientist, with whose name will be linked for ever one of the greatest victories of the science and technique - the start of the era of mastering by mankind of the outer space.

S.P. Korolev being a young scientist in 1932 imbued with ardent faith in Tsiolkovskii's ideas of interplanetary flights and mastering by mankind of the outer space begun working in the sphere of the space-rocket technique and became one of the leaders of the largest scientific and technical groups on creation of this technique.

Devotion to the cause, unusual talent of the scientist and designer, ardent faith in his ideas, tireless energy and outstanding organizational capacity of the Academician Korolev have played a great role in the resolution of composite scientific and technical problems, blocking the way to the development of the rocket and space technique. He had a great gift and daring of the scientific and technical foreseeing, and this assisted putting into practice the most difficult scientific theory projects.

Sergei Pavlovich Korolev was an outstanding designer of space-rocket systems, which assured achievement of the main stages in the investigation of the outer space. This was the first artificial earth satellite - beginning of the space era, many satellites, which created new epoch in the physical properties study of the outer space, first flight to the moon, orbiting around the moon and photographing of the other side of the moon, spaceship-satellites and the first in the world manned flight into space, first exit of a man into outer space.

Many scientific and technical ideas of S.P. Korolev were extensively used and developed in rocket and space technique. He trained many scientists and engineers, working today in various scientific and designing organizations.

S.P. Korolev had devoted his life to the selfless service of his Motherland, to development of the advanced science and technique of our country. His great talent, inexhaustible energy and warm heart have made him deeply respected by any one who knew him, who worked with him. Academician Sergei Pavlovich Korolev is one of those remarkable scientists of our culture. His work deserves deep gratitude in our country, of the **entire** Soviet people and was recognized by Government, which confered on him highest decorations.

Memory of S.P. Korolev and of his contribution to science and technique will for ever remain in the hearts of our people and in the history of the world science.

"Pravda", 19th January 1966. (TASS).

TASS COMMUNIQUE "LUNA-9" IN SPACE.

On 31st January 1966 launching was accomplished in the Soviet Union of the automatic station "Luna-9".

The station carries scientific, telemetric and other measuring instrumentation, which is cut-in automatically in accordance with the flight program, as well as on commands from the earth.

The station's flight is being tracked by a special measuring complex.

The preliminary results of the measurements processing show, that the lunar trajectory of the station is close to prescribed. All instruments aboard the station operate normally.

According to data of coordination-computing center, at 18 hours Moscow time on the 31st of January with coordinates 49°30' N and 74° E.

"Pravda", 1st February 1966.

TASS COMMUNIQUE NEW OUTSTANDING ACHIEVEMENT OF THE SOVIET SCIENCE AND TECHNIQUE. "LUNA-9" LANDED ON THE MOON.

On the 3rd of February 1966 at 21 hours 45 minutes 30 seconds Moscow time the automatic station "Luna-9", launched on the 31st of January, performed a soft landing on the surface of the moon in the area of Oceanus Procellarum, west of Reiner and Marius craters.

Radio-communication with the station on the moon's surface is steady. The transmission is carried on frequency 183.538 megacycles per second. Instruments aboard the station operate normally. The next period of radio-communication will take place from 0 hours to 0 hours 14 minutes Moscow time on the 4th of February.

"Pravda", 4th February 1966.

TASS COMMUNIQUE. "LUNA-9" TRANSMITS PICTURE OF THE LUNAR SURFACE.

After a successful accomplishment of the soft landing on the moon's surface, steady radio-communication was established with the station "Luna-9". On the 4th of February four periods of radio-communication were conducted with the station of total duration 3 hours 20 minutes.

During these periods telemetric information was received from the station confirming normal operation of the systems aboard. On the 4th of February at 4 hours 50 minutes Moscow time command from the earth the station "Luna-9" begun scanning of the lunar landscape and transmission of its picture to the earth.

Information incoming from the station is being processed and studied.

The successful implementation of the program by "Luna-9" is the result of successive implementation of the plan, marked for moon investigations. The routine periods of radio-communication with "Luna-9" took place on the 4th of February from 18 hours 30 mintues and 5th February from 4 hours Moscow time.

"Pravda", 5th February 1966.

To scientists and designers, engineers, technicians and workers, all groups and organizations, participating in construction of automatic station "Luna-9" and accomplishment of the soft landing on the moon.

Dear comrades, friends !

Our Soviet Motherland has written a new page in the history of the space conquest. On the 3rd of February 1966 for the first time in history a soft landing was accomplished on the moon of the automatic station "Luna-9". From the surface of the age-long satellite of the earth a successful beginning was made of the radio-television transmission. The accomplishment of the soft landing on the moon is an outstanding victory of the Soviet science and technique, being the most important step in the conquest of the space after the launching of the first artificial earth satellite, first manned flight into space, first exit of the spaceman from the vehicle.

In resolving the problem of the soft landing on the moon the Soviet scientists and designers had to follow an unbeaten track, to resolve quite new for the space technique questions. And today with joy and pride we can inform the world, that the Soviet people in their persistent creative labor have successfully accomplished even this, the most difficult problem.

It is significant, that this scientific exploit was accomplished on the eve of the XXIII convention of the CPSU - a historic event in the life of our Party and the entire Soviet People.

The Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of USSR and the Council of Ministers USSR warmly congratulate scientists and designers engineers, technicians and workers, collectives and organizations, participating in designing constructing, launching and assuring flight of the automatic station "Luna-9", all those, who by their selfless labor made possible new important achievement in astronautics - soft landing of the automatic station on the surface of the moon.

Glory to the Soviet hero-people, creator-people, transformer-people!

Long live Communist Party of the Soviet Union - inspirer and organizer of all our victories for the good of the Motherland, in the name of the triumph of communism!

Central Committee CPSU Presidium of Supreme Council USSR Council of Ministers USSR.

"Pravda", 5th February 1966.

TO CENTRAL COMMITTEE OF CPSU PRESIDIUM OF SUPREME COUNCIL USSR COUNCIL OF MINISTERS USSR.

We, scientists, designers, engineers, technicians and workers, participating in construction and launching of automatic station "Luna-9", just as all Soviet people, are proud of the great contribution of our socialist Motherland to the mastering of cosmos, which has become possible due to constant support and encouragement of our Party, Government and efforts of all the people.

The flight of the "Luna-9" opens a new era in the mastering of the outer space and the time is not far off, when a man's foot will step on the moon. The whole world became convinced in the great creative possibilities of the socialist order.

The congratulations of the Central Committee of CPSU, Presidium of the Supreme Council of USSR and the Council of Ministers of USSR were greeted with great joy in our collectives. We warmly thank the Central Committee of the CPSU, Presidium of the Supreme Council of USSR and the Soviet Government for high appreciation of our labor and kind siwhes.

The results of our labor, terminated in successful flight and soft landing of the Soviet space vehicle on the moon, we dedicate to forthcoming XXIII convention of the Communist Party of the Soviet Union.

We assure the Central Committee of CPSU, Presidium of the Supreme Council of USSR and the Council of Ministers USSR, that henceforth also we shall persistently work on the resolutions of difficult problems in further mastering of the outer space, to labor selflessly for the Glory of the Soviet People, in the same name of the great future of our Motherland.

"Pravda", 6th February 1966.

TASS COMMUNIQUE "LUNA-9" CONTINUES SURVERY OF THE LUNAR SURFACE.

The station "Luna-9" at point of lunar surface with coordinates 7°8' N and 64°22' W, continues to carry out the planned program of the moon's investigations.

During the period of communication, which took place on the 4th of February from 18 hours 30 minutes to 19 hours 55 minutes Moscow time, the station transmitted to the earth a circular panorama of the lunar landscape. Moreover, on radio-commands, transmitted from the ground center of space communication, on selection of scientists a detailed review was conducted of individual areas of the moon's surface.

The pictures, received on the earth, are of good quality. The obtained information is being analysed by the scientists and will shortly be published.

On 5th February at 4 hours the communication period was for reception of telemetric information from aboard the station. This communication has shown, that parameters aboard the station (pressure, temperature, power-supply voltage, etc.) are within the prescribed limits. The next period of communication is set for the 5th February from 19 hours Moscow time.

This period of communication will complete the planned program of the moon's investigation by automatic station "Luna-9".

"Pravda", 6th February 1966.

THE GREAT ACHIEVEMENT OF MANKIND.

The first Automatic Station on the Moon.

On the 3rd of February 1966 at 21 hours 45 minutes 30 seconds Moscow time the Soviet automatic station "Luna-9" has soft-landed on the moon. On the 4th of February on command from the earth the station begun scanning of the lunar landscape and transmission of its picture to the earth. For the first time in history a man-made space vehicle accomplished a landing on the moon in order to transmit scientific information from its surface.

The soft landing on the moon - a celestial body without atmosphere, represents one of the most difficult technical problems of astronautics. Due to the absence on the moon of atmosphere, deceleration of the space vehicle prior to landing could be implemented only by means of the rocket engine and is bound with the need to have aboard the vehicle considerable reserves of fuel, composing approximately half the weight of the vehicle prior to deceleration.

For the soft landing on the moon it is necessary to control the initial moment of the deceleration and the thrust of the space vehicle during deceleration so, that velocity will be down to zero immediately before the touchdown on the moon's surface. The fulfillment of these conditions requires special radio-system of soft landing and corresponding flight control system of high precision.

Soft landing of the station "Luna-9" was preceded by launching of lunar stations, which made it possible to perfect in natural conditions trajectory control system, radio-set aboard, orientation reference system and independent control devices.

Perfecting soft landing of automatic lunar stations will enable to resolve the most important problem of obtaining data about the physical conditions on the moon, its surface properties and relief.

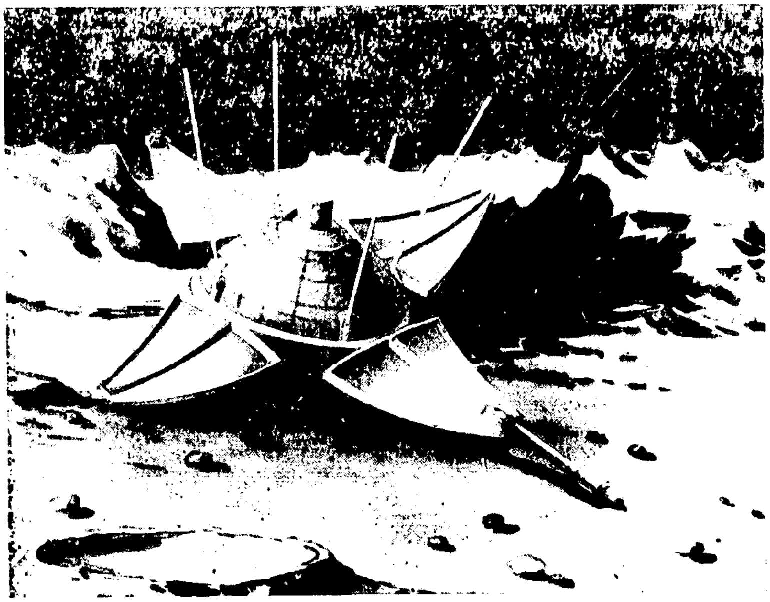

Fig.1[illegible]. Automatic station on the moon's [illegible] ([illegible]).

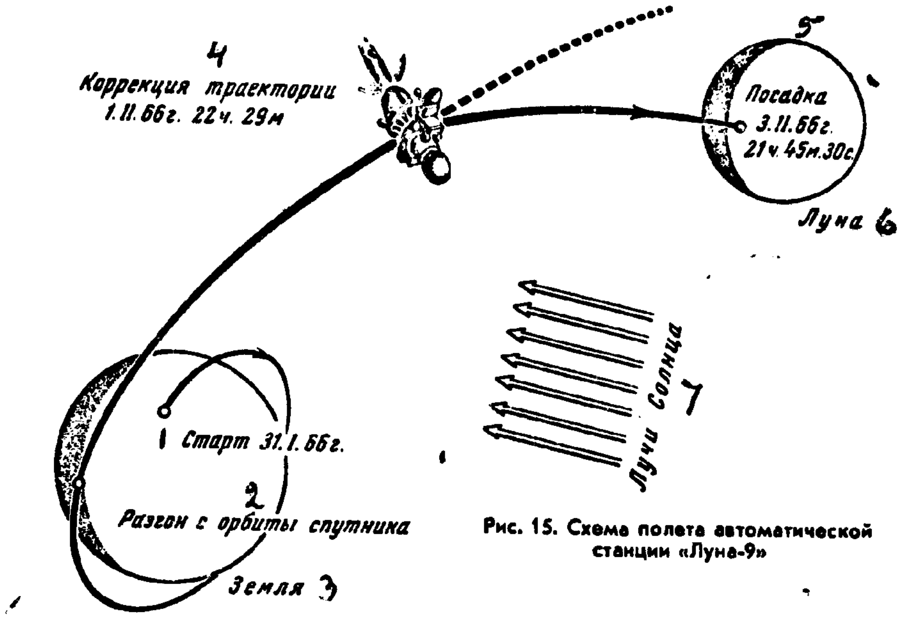

Рис. 15. Схема полета автоматической станции «Луна-9»

Fig.15. Flight diagram of the automatic station "Luna-9".

1- Start 31.1.66; 2- Acceleration from the satellite orbit; 3- Earth; 4- Trajectory correction 1.2.66 at 22 hours 29 minutes; 5- Landing 3.2.66 at 21 hours 45 minutes 30 seconds; 6- Moon; 7- Sun rays.

Soft landing on the moon is a necessary step for further development of astronautics and man's mastering of the moon.

The station "Luna-9" is made up of three main parts: the automatic station itslef, which has to be landed on the moon's surface so "softly", that the instruments in it would retain their working capacity; propulsion system, meant for trajectory correction and deceleration on the flight to the moon; compartments containing flight control system. A part of control system not used during the deceleration is disposed in two hanging compartments, separated immediately prior to the start of decelerating motor.

Automatic lunar station is an air-tight container, which carries radio receivers and transmitters, programming device and timer, thermal control system, scientific instruments and power-supply sources. The station includes television system for circular scanning with transmission of the lunar landscape picture to the earth. (More detailed information about the TV system will be published separately).

On the body of the station are the antennas, which automatically open after the touchdown, shock-absorbing system to soften the impact at the moment of touchdown, and metal lobes, protection TV set from possible shocks during the landing and making the position of the station more steady on the moon's surface.

The propulsion system of the station consists of rocket engine with fuel-feed pump, control members for flight stabilization during engine operation and fuel tanks.

Control compartments contain a set of gyroscopic and control devices, electron-optical arrangement for the station's orientation in flight, orbital radio-control, timer for operational sequencing, soft-landing system, power-supply sources and orientation system motor.

The constructive connection of the automatic lunar station with propulsion system and control compartments is made in a way, that at the moment, preceding touchdown, the lunar station separates and comes down offside from the point, where the propulsion system came down.

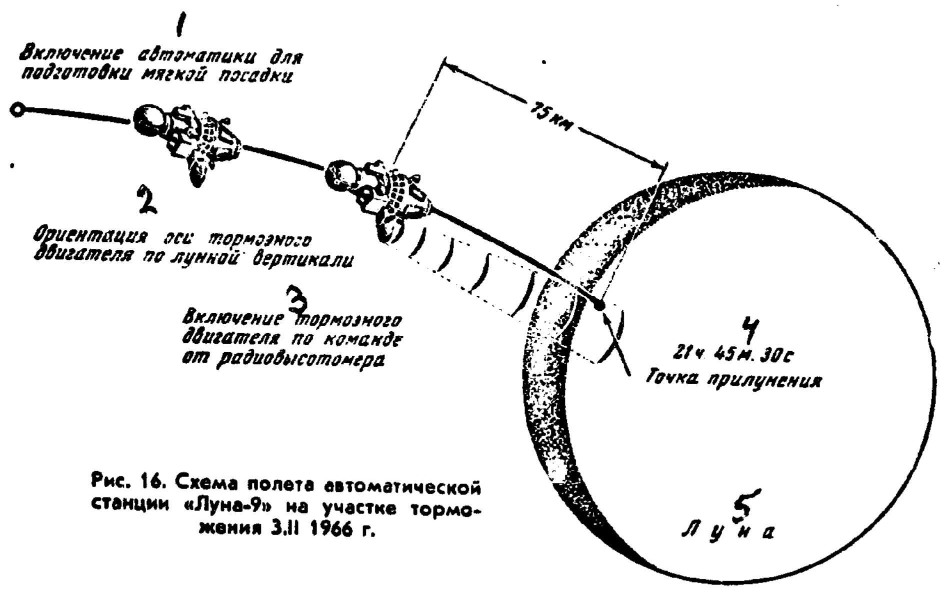

Рис. 16. Схема полета автоматической станции «Луна-9» на участке торможения 3.II 1966 г.

Fig.16. Flight diagram of the automatic station "Luna-9" in deceleration section 3.11 1966.

1- Cut-in of automatics for preparing soft landing; 2- Axis orientation of decelerating engine on lunar vertical; 3- Cut-in of decelerating engine on command from radio-altimeter; 4- 21 hours 45 minutes 30 seconds touchdown point; 5- Moon.

The weight of station "Luna-9" after insertion into lunar trajectory composed 1583 kg. The flight diagram of the automatic station "Luna-9" is shown in figures 15 and 16. Typical for this diagram are the following features:

- at the first stage of flight the carrier-rocket inserted into orbit of earth satellite the automatic station "Luna-9" with boost cluster for the subsequent boost off the satellite orbit;
- at the second stage of flight the boost cluster was started and the automatic station inserted into lunar trajectory;
- the third stage was the trajectory orrection, assuring impact of the automatic station with the moon's surface in prescribed plains area of the Oceanus Procellanum;
- the fourth stage of the flight - deceleration and soft landing on the moon's surface.

The selection of 31st January 1966 for the launching of "Luna-9" was timed for lunar morning in the area of Oceanus Procellanum. During the period of lunar morning the temperature and conditions for operation of radio and TV sets of the station are more suitable. At the touchdown moment of "Luna-9" the sun was above the local horizon at an angle of about 3°.

For the successful flight of the "Luna-9" it was important, that the coming of lunar morning in the area of Oceanus Procellanum should coincide with relatively high position of the moon above the earth's equatorial plane. The latter condition provides for sufficiently lengthy periods of direct radio-visibility of the moon from the territory of the Soviet Union.

The earth satellite orbit, into which the "Luna-9" was inserted, has the following parameters:

- altitude at perigee 173 km;
- altitude at apogee 224 km;
- orbital inclination about 52°.

The duration of the flight - about 3½ days was selected on basis of assuring the highest possible weight of the automatic station.

The total fuel consumption, and therefore the weight of the scientific instruments of the station, depends on the energy consumption for the boost off the earth's satellite orbit, for trajectory correction and for deceleration at the surface of the moon.

With reduction in duration of flight along the earth-moon trajectory fuel consumption increases for acceleration at the earth and deceleration at the moon. Thus, for instance, with duration of flight 3.5 days deceleration near the moon has to be of velocity 2600 m/sec., and with duration of 2.5 days - about 2800 m/sec. On the other hand, with reduction of fuel consumption for acceleration at the earth and deceleration at the moon its consumption increases for trajectory correction, since with increased duration of flight the error considerably increases of insertion into trajectory deviation from the moon.

It has been fixed by calculations, that the highest weight of the scientific instruments on the automatic station is obtained with duration of flight for about 3-4 days. In the final choice of flight duration (3½ days) the recuirement was taken into account for the station at the moment of touch down and for some time afterward to be close to the culmination point above the horizon of control center.

The insertion of the automatic station "Luna-9" into lunar trajectory was accomplished on the 31st of January 1966. The subsequent trajectory measurements from ground points of space communication, carried out during the night 31st January-1st February made it possible to fix, that the automatic station is moving along the trajectory, passing at a distance of about 10 thousand km from the center of the moon. In accordance with the obtained forecast of the actual movement of the station the command control center prepared primary data for correction the quantity and direction of correcting impulse, appropirately coded for transmission aboard by radio. On the 1st of February 1966 these data were transmitted aboard the station.

The correction maneuver begun on command from the earth. Subsequent operation of all the station's systems during this maneuver was carried on automatically - in accordance with prescribed program of the automatics aboard the station.

At the start of the correction maneuver the station by means of optical system and micro-rockets was oriented on the sun. Thereafter, while retaining the same orientation, optical search was conducted of the moon and orientation on the moon so, that the axis of propulsion system would be in the plane, perpendicular to direction to the moon. The position of the orientation system's optical pipe in relation to the body of the station was preset by commands from the earth and selected with an estimate for the engine axis to take the required position.

The propulsion system was cut-in on completion of orientation at 22 hours 29 minutes on the 1st of February.

The engine cutoff was implemented by control system after communication to the station of prescribed correcting velocity.

As a result of correction the velocity of the station "Luna-9" changed in required direction by 71.2 m/sec., and the corrected trajectory was passing practically through prescribed point of landing in the area of Oceanus Procellanum.

To ensure the prescribed accuracy of landing on the surface of the moon high precision is required of correction. Thus, deviation in correction velocity by 0.1 m/sec results in deviation on the surface of the moon of 10-15 km. Deviation of velocity vector in plane, perpendicular to lunar trajection, by 1 angular minutes results approximately in the same deviations of the landing point on the moon. After correction new measurements were carried out from the ground control center. These measurements confirmed high precision of correction.

The preliminaries begun of the final stage of the flight - deceleration and soft landing on the moon's surface. From the results of trajectory measurements primary data were estimated at Coordination center for deceleration: deceleration impulse, tuning of the astro-orientation system and correction for the initial working moment of decelerating engine. At 16 hours on the 3rd of February primary data for decelerating maneuver were transmitted aboard the station.

During the communication periods besides trajectory measuring and transmission of primary data telemetric information was transmitted from aboard the station on the functioning of the systems aboard, temperature conditions of the station and pressure in its individual compartments.

In approaching the moon operations begun for preparing the station for the landing. To implement deceleration the station at a given moment had to be oriented so, that the motor nozzle would be directed at the moon. The orientation was done an hour before the approach by plotting lunar vertical by optical instruments.

The use in this case was one of the properties of a bunch of hyperbolic trajectories: if the cut-in height of the motor is prescribed, there is existence for this height of a distance from the moon's center (approximately 8500 km), at which the line to the center of the moon coincides with the needed direction of thrust at the initial moment of deceleration. It should be mentioned, that this distance practically does not depend on the amount of deviation of the actual trajectory from the prescribed.

At a certain moment, corresponding to altitude of 8300 km, the station jointly with propulsion system was oriented exactly on the lunar vertical. Then by means of the optical tracking system of the sun and the earth this course was retained for about an hour - upto operation of the braking rocket.

It is significant, that the method of orientation prior to deceleration, used on the "Luna-9", assures independent initial orientation of the engine axis by velocity vector.

At an altitude of about 75 km from the surface of the moon, 48 seconds prior to landing, on command of radio-altimeter the braking rocket was cutin. Before the cutin of the engine, separation was made of the 2 compartments with instruments not used in landing. During operation of the engine the shock-absorbers were made ready for touchdown. Landing control system assured deceleration of velocity from 2600 m/sec to just a few meters per second at low altitude above the surface.

At the instant of reaching the moon's surface the automatic lunar station with shock-absorbing system was separated from the propulsion system and landed near by. The lunar station descended on the surface of the moon on the 3rd February at 21 hours 45 minutes 30 seconds.

4 minutes 10 seconds after the station's landing on the moon the antennas opened out and the first radio transmission begun from the moon. This and subsequent periods of radio-communication with the station have shown, that all its systems operate normally, air-tightness of body during landing was not disturbed, thermal control system assures the required temperature conditions, radio-communication with the station steady, the instrumentation is reliably controlled by commands from the earth.

On the 4th of February at 4 hours 50 minutes on commands from the earth station "Luna-9" begun scanning of the lunar landscape and transmitting its picture to the earth.

The "Luna-9" landed in the area of Oceanus Procellanum at a point with coordinates $7^{\circ}08'$ N and $64^{\circ}22'$ W.

The Oceanus Procellanum is the larges of "maria" on the surface of the moon and lies in the western marginal zone of its visible hemisphere.

As we know, there are two main types of structures on the moon: the light, extremely intersected by craters masses of "continents" and dark, comparatively even "marine" areas. The number of large craters in "maria" is considerably less, than on the continents. But speaking of craters less than half kilometer in size, their number in "maria" and continents" are practically the same.

The landing of the interplanetary automatic station "Luna-9" took place west of craters Marium (diameter 41 km) and Reiner (diameter 30 km). Close to the point of landing are also the craters Cavelerius (diameter 64 km) and Galileus (16 km). The largest in the area of landing is the Hevelius crater (diagram 118 km).

The "marine" area selected for the soft landing of "Luna-9" is typical in many respects and presents an undoubted interest for detailed survey, the results of which could be extensively used in future cosmic experiments.

The outstanding scientific achievement - landing on the moon of the Soviet automatic station "Luna-9" - brings closer the time, when for the first time a man's foot will step on the surface of the moon, and then on the natural satellite of our earth will be constructed scientific bases and observatories.

At present it is still difficult to enumerate all the spheres of the human knowledge, which will be interested in observations at the lunar scientific base. However, perfect may be the devices at our disposal on earth, it will never be possible to reproduce all those conditions, which exist on the moon.

It is a known fact, that some components of terrestrial atmosphere (ozone, water vapor, carbon dioxide) absorb the major part of radiation, incoming to us from other celestial bodies. The most important information, which would have made it possible to study physical processes, taking place at other celestial bodies, does not reach the earth. Even in the radio-frequency region, where the components of terrestrial atmosphere are not quite transparent, there is only a comparatively narrow "transparency window", beyond which the terrestrial ionosphere reflects radiations, incoming from the outer space.

From the astronomical point of view observatory on the moon will be in extremely favorable conditions. Absence of atmosphere will not only eliminate the absorbtion, but will also result in the fact, that the images in the telescope will cease to vibrate and "twinkle". For the observation of a number of astronomical objects, for instance of planets, it will be possible to use magnification many times greater, than is admissible on the earth. And the conditions of observation will be entirely different. The point is, that the time of the complete revolution of the moon about the axis composes about 650 hours. For more than three hundred hours the luminaries under study will be continuously above the horizon at lunar night. The absence of atmosphere will also eliminate the bright background and will make possible observation of stars and planets also during the lunar day.

Safety service will be set up at lunar observatory for distant flights of spaceships with crews. Study will be conducted of X-rays, ultraviolet and corpuscular radiation of the sun, required for predicting its state.

All the sections of astronomy are interested in observations of this type of observatory. Radio-astronomy will investigate cosmic radio-emission, including galactic radio-frequency radiation and flashes of Super-Nova stars. Investigation of the Milky Way region and of other objects will be of importance for resolving cosmogonic problems of stellar astronomy. Of importance for astronautics will be the astrometric work on verification of fundamental astrononic constants, composition of catalogues, maps, etc.

Scientific bases on the moon will enable to conduct the study of earth in entirely new way. For the first time it will be possible to set up investigation of the radio-emission conditions of our planet, seasonal fluctuations of its brightness, systematic photographing of the earth. Meteorological service will get information at once on the whole hemisphere of the earth including such difficult for investigation regions as oceans and polar basins. Information, transmitted by artificial earth satellites, cannot give such a global picture. Lunar observatory will assist in the weather forecast on the earth.

It is interesting to mention, that from the moon it will be possible to observe on the earth objects of some tens of meters in size, i.e. hundreds and thousands of times smaller, than can be observed on the moon with the same instruments from the earth. Moreover, the quality of image, visible in the telescope, installed on the moon, will be very high, since the dusty and continuously moving terrestrial atmosphere will be in the immediate vicinity of the object of observation - terrestrial surface.

Special place will be taken by the investigations of the moon itself. Investigations will be conducted of the physical conditions on the lunar surface, structure study of its soil, figure of the moon, seismic, gravity and magnetic survey, explorations of useful minerals, large-scale mapping.

It should be mentioned, that these investigation could begin by means of automatic lunar stations, of the type of "Luna-9".

Of great significance for the theory of the origin of the Solar System will have history investigations of the development of lunar formations. The absence of atmosphere and water in a free state resulted in the fact, that the oldest formations on the lunar surface were retained in their primary form for many millions of years.

The specific conditions of the lunar surface make it very convenient for conducting a number of important scientific investigations. For instance, investigations in the sphere of high vacuum technique and electronics could have obtained on the moon, where the vacuum is unlimited, a great range.

Enticing prospects open out for investigations in the sphere of biology and medicine. How will the plant and animal organisms behave in conditions of low gravity? How will the physiological processes change? These and many other questions could be studied with long-term presence of living organisms and man on the surface of the moon.

At present it is difficult to foresee the enormous effect on the development of various sciences of the new knowledge, obtained at the lunar scientific bases. One thing is certain - it will be a new stage in the development of a whole series of branches in the science and technique.

The accomplishment of the soft landing on the moon is an outstanding victory of the Soviet science and technique, being the most important stage in the mastering of the space after the launching of the first artificial earth satellite, first manned flight into space, first exit of the spaceman from the vehicle.

"Pravda", 6th February 1966.

TASS COMMUNIQUE INVESTIGATION PROGRAM OF THE MOON BY MEANS OF AUTOMATIC STATION "LUNA-9" HAS BEEN SUCCESSFULLY COMPLETED.

On the 5th of February from 19 hours to 20 hours 41 minutes Moscow time radio-communication was conducted with automatic station "Luna-9", which has completed the planned program of moon investigations by means of the automatic station "Luna-9".

The TV pictures, transmitted from the station "Luna-9", are unique and, according to preliminary conclusions of scientists, are of exceptional scientific value for structure and features determination of the moon's surface.

"Pravda", 7th February 1966.

TASS COMMUNIQUE ONE MORE PERIOD OF RADIOCOMMUNICATION.

As communicated to the press, the investigation program of the moon by means of automatic station "Luna-9" has been successfully completed.

At the same time, taking into account the fact, that the current sources aboard still had some power reserve, in excess of calculated, an additional two-hour radio-communication was conducted with the station "Luna-9", which begun at 23 hours 37 minutes Moscow time on the 6th of February.

During this period telemetric information was received from aboard the station, characterizing performance of the systems, temperature conditions of the station, and repeated pictures of some sections of the lunar panorama.

During this period almost the whole reserve was consumed of the power in current sources, therefore radio-communication with "Luna-9" has ceased.

Altogether seven periods of radio-communication have been conducted with the station "Luna-9" with total duration of 8 hours 5 minutes.

The unique TV pictures of the moon's surface and scientific information obtained will be studied and investigated.

Investigation results will be published in the press.

"Pravda", 8th February 1966.

A NEW EPOCH IN THE KNOWLEDGE OF THE UNIVERSE.

Press Conference in the Moscow Club of Scientists.

"Moon Week", which had the whole world in its grip, starting from that memorable evening of the 3rd of February, when exactly according to the time-table, at 21 hours 45 minutes 30 seconds Moscow time, the Soviet automatic station "Luna-9" accomplished soft landing on the moon's surface has terminated on the 10th of February by press-conference of the Soviet and foreign journalists in the Moscow Club of Scientists.

Every day of this week brought new events, staggering the imagination, causing admiration by the greatness of the human genius, inexhaustible creative possibilities of the Soviet science and technique, our people, creating genuine miracles.

Watching pictures of the lunar landscapes, obtained in direct contact with them, while present at the TV transmissions, which as though transported us into the cold spectral bleakness of the lunar world, the people asked themselves: "But how it became possible?", "What did the moon reveal to Moscow?".

The hall of The Scientists Club is filled to capacity. There is clicking of numerous photo-cameras, whirring of cine- and TV cameras, which record the unique pictures of the lunar surface, shown to the press-conference.

The journalists are being addressed by M.V. Keldysh, President of the Academy of Sciences USSR.

The "White Spots" are Less.

Comrades, Ladies and Gentlemen!

The launching of the first artificial earth satellite has opened a new epoch cognition of the universe. Scientific determinations on satellites and distant space rockets have provided a lot of new important information on circumterrestrial space, on processes taking place in the outer space at enormous distance from the earth. With the first manned flight of the spaceship satellite the mankind has entered an era of space flights. The next most important step is the accomplishment of interplanetary flights, first with automatic vehicles with delivery of scientific devices to other celestial bodies and hence manned flights. These are the most important steps in the development of science and mastering of universe by a man. The station "Luna-9" has accomplished for the first time soft landing on the nearest to us celestial body - the moon. The landing was in the eastern part of Oceanus Procellarum, in the vicinity of equator. During the next three days there was a regular transmission to the earth of the TV pictures of the lunar surface and of various telemetric information. The flight and landing of the automatic station "Luna-9" is a great event in the development of astronautics.

Observations of the moon for many years from the earth's surface have given a lot of valuable information regarding its nature. By means of optical telescopes, with the use of instruments, based on the latest achievements of physics, and also of radio-telescopes and radar measurements were conducted, requiring high experimental skill. They made it possible to determine the size of the moon and its path around the earth, the shape and disposition of topographical details, to obtain information regarding temperature conditions of the lunar surface, color of lunar soil, dispersion laws of light and radio-waves.

However, from the earth it is impossible to distinguish details of less than 300 m in diameter. Very limited are the data on various physical characteristics of our natural satellite and its surface.

The flights of the Soviet lunnics have opened a new page in the study of the moon and circumlunar space. As a result of launching in September 1959 of the automatic station "Luna-2" the absence was proved on the moon of any appreciable magnetic field and radiation zone. In October 1959 "Luna-3" for the first time photographed the other side of the moon and transmitted by television to the earth pictures of enormous scientific value. Photographs, transmitted by the automatic station "Zond-3" in July 1965, hardly left any "white spots" on the invisible side of the moon. Pictures of the visible side of the lunar surface with high resolving power were obtained as a result of launching American spaceships "Ranger" in 1964-1965.

However, such characteristics of the moon, as chemical and mineralogical composition of the surface, structure of the lunar interior, seismic nature of the moon, are of hypothetic nature.

quite unusual according to terrestrial concepts, physical conditions on the moon - the most intense vacuum, effect of active radiations of the sun for milliards of years, continuous falling of meteorites, low gravity - should create special, unknown on the earth structures of lunar surface.

On basis of data from terrestrial observation the assumptions were of various types: on the dust cover, pumice or slag structures, lava flows, about the special, non-existent on earth open-work structures, formed due to the adherence of fine particles of lunar ground.

The accomplishment of the soft landing opens the ways for studying these properties. Outstanding scientific value have the already transmitted by "Luna-9" pictures of the lunar landscape around the station. We could see for the first time quite close a piece of the moon's surface. We see, that the surface of the moon consists of sufficiently strong rocks of the type of pumice or slage. It must be quite firm for the station not to sink. Undoubtedly, further conclusions, which will be drawn as a result of detailed study of these unique pictures, will greatly supplement our knowledge of the lunar surface. The subsequent automatic stations will make it possible to investigate the mechanical and physical characteristics of the lunar ground, composition of lunar rocks, variations of surface temperature and many other valuable data on the moon.

The problem of accomplishing soft landing on the moon is extremely difficult in technical respect. There is no atmosphere on the moon, which could have decelerated the movement of the spaceship, approaching at velocity of about two and a half kilometers per second. The problem was rendered even more difficult by the absence of any information regarding the properties of the lunar surface. The only way to accomplish soft landing is the extremely precisely adjusted braking of space vehicle by rocket engine. The brake rocket engine should reduce velocity of the vehicle to a few meters per seconds; moreover termination of braking should coincide with the moment of approaching the moon's surface, otherwise the vehicle due to free fall will again pickup velocity. For implementation of the soft landing on lunar surface it was necessary to combine quick-acting and exact control automatics with perfect measuring means. Description of the station "Luna-9" and of the whole flight to the moment of landing on the moon are widely published.

I would like to mention, that the successful accomplishment of this achievement owes a lot to the late S.P. Korolev.

The flight of station "Luna-9" opens out enormous possibilities in the study of the moon and is the greatest step on the way to accomplishment of manned flights to other celestial bodies. This flight is a great success of the Soviet scientists, engineers and workers, a new outstanding contribution of our country to the progress of mankind.

Permit me to thank you for your attention and to open the press-conference.

The speaker is Professor A.I. Lebedinskii.

What was Seen by a Cosmic "Eye".

An outstanding scientific event took place - the automatic station "Luna-9", so to say, "had a look at lunar landscape through the eye of a spaceman".

The height of its TV camera above the ground level is about 60 cm, which at an even area of lunar surface assures visibility distance of about 1.5 km. The man's height exceeds that of the station and his radius of view would have been 2.3-2.5 km.

The resolving power of the station's TV "eye" is about 3 arc minutes, whereas for a man of good eyesight it is in the order of 1 minute. Close to its base the camera discerns almost the same details, as would have been seen by a man without bending.

The "eye" of the station, similar to human eye, has the capacity to vary its sensitivity in relation to illuminance. This is done automatically by means of a photoelectric device on board, as well as on commands from the earth.

"The automatic spaceman" surveyed the surrounding locality several times, at various positions of the sun above the

C-6

horizon. This is most important, as it provides the possibility to investigate the irregularities on lunar surface. The fact is, that the appearance of the lunar landscape varies extremely with the rising of sun above the horizon. On pictures, taken during the first period of communication, due to long shaws and dependence of the surface brightness of the angle of incidence of solar rays even the very gentle irregularities of the ground are noticeable, but many details in the shadow of screening objects are lost and the visibility is very poor, due to bright spots, of the eastern sector of the panorama, wherethe sun is.

The most effective is the panorama of the third period of communication, when with the height of the sun about 27^{o} the bright spots have disappeared, whereas the shadows still quite well emphasize the hollows and projections with sharp edges. With the further rise of the sun decrement of shadows makes the pictures less graphic.

The series of panoramic pictures at different height of the sun above the horizon makes it possible, figuratively speaking, to define the pattern of surrounding the station landscape, and only in the deepest hollows the depth remains undefined, as during the station's operation the sun could not light up their bottoms.

About the distance of the objects from the station it is possible to judge approximately by their angular distance from horizon. For exact measurements of distance the use is of dihedral corner reflectors, in which the reflection is of six narrow strips of landscape. Obtained for these strips were pairs of stereoscopic pictures with base of about half a meter.

Between the second and the third transmission of panorama the station shifted, thereby changing by a few degrees the inclination of photo-television camera, and the camera itself shifted by a few centimeters. This provides an additional possibility of using stereo-effect for distance determination to objects, visible from the station.

The touchdown place of the station was selected in the vicinity of the morning part of the lunar terminator, i.e. where the sun has just risen. At the moment of landing on the moon the sun was too low above the horizon, therefore the first transmission of the panorama begun after four hours, when the height of the sun reached 7°.

Landing on the moon in the vicinity of the terminator's morning part was expedient from the viewpoint of selecting the optimum thermal conditions of the station. As we know, at lunar noon on the equator temperature of the ground is upto $120^{\circ}C$, and at night drops to -150°. Therefore, the most favorable for the station's operation time is the lunar morning, which lasts for several terrestrial days - the sun already warms the station, but has not as yet heated lunar surface to high temperature.

Working period of the station was determined by its power resources, and according to the program the functioning of the station should have terminated by the third TV transmission of the panorama. However, there was still small reserve of power left and the last transmission of information was conducted 75 hours after landing on the moon.

Let's turn now to the panorama. It shows a landscape, surrounding the station, and a number of construction details of the station itslef. The station's detail appear very large, as they are close to the TV camera. In order to imagine the resolving power of the camera at near distances, take a look at the photometric scale in the left part of the panorama. Its size is no larger than a match box, and the thickness of the cord visible here is about a millimeter. The scale is colored by paints with a certain reflection factor.

The ground around the station was hilly, with separate craters, possibly of meteorite origin, in diameter from one to several meters. The whole ground is covered by a great number of small hummocks and depressions upto minute ones with size in millimeters. To me personally, from the first impression it seems, that the material of the lunar surface at the touch down place of the station has been subjected to multiple reprocessing. It was crushed as a result of bombardment by meteorites, then joined into a hard rock by diffusional vacuum cementing, cracked due to sharp variations of temperature in the change of day and night, and specially during the solar eclipses, became again crushed, joined and cracked. And all this was repeated, many times during the many hundreds of millions of years, resulting in porous as the eupatorian yellow sandstone, or to be exact, more porous than this sandstone, hard, but not strong rock.

Station "Luna-9" made it possible not only to see, but also to estimate the strength of the lunar ground. It was sufficiently strong for the station not to sink appreciably.

During the flight of the automatic station "Luna-9" measurements were conducted of the radiation doses, existing in the interplanetary space and on the moon's surface. As shown by the interpretation of obtained signals, the intensity of radiation on the moon's surface is determined mainly by cosmic rays. The dose is 30 milliard per day. Additional radiation was detected from the moon. This radiation is caused, apparently, by nuclear reactions, occuring under the effect of cosmic rays in the surface layers of the moon. We hope, that further investigations of this radiation may uncover the secrets of the chemical composition of moon rocks.

The address of V.P. Vinogradov, academician.

Hilly Stone Desert.

Before we deal directly with the surface nature of the moon, I must make a few preliminary remarks.

The surface nature of the small planets, such as the moon, is determined primarily by the size of the planet itself. The result of this is the absence on their surface of gaseous and aqueous envelope due to loss of water and gases in the field of low gravitation.

We have shown experimentally, that the external sheath of the planets - earth crusts - are formed by the melting out of fusible matter onto the surface of the planet. This differentiation of the matter on the surface of the moon and other earth planets into sheaths is the result of heating by the radio-active heat, as a result of which the primary meteoric matter of the planet splits into unfusible and fusible phases. The fusible phase is a basalt mater and flows out in the form of lava onto the surface of the planet. The ascent of basalt magna to the surface of the planet occurs by the mechanism of zonal melting, i.e. independently of its lower density, but as a result of its fusibility. This melting out of the basalts is accompanied by degassing of water, acid fumes of volcanic eruptions. Perhaps, it is interesting to recall, that basalt outflows on the earth are accompanied simultaneously by degassing of upto 5-10 percents of the water vapor, moreover this water vapor contains upto 10-15 percents of acid fumes - carbon dioxide, hydrofluoric acid and other aggressive gases. The volcanic landscape of the moon indicates the same process. Maximum transverse dimensions of the craters on earth - 30 kilometers, on the moon in the field of low gravitation and in the absence of atmosphere - upto 300 kilometers. The outflow of the basalt lava on the moon takes place in the vacuum. Therefore, its release from the gas phase, water vapors occurs differently, than on the earth. For instance, gas bubbles in lava and gas hollows could have been here of much larger size, than in the similar process on earth. Gases, water due to the same factors flew off the moon and were transferred into space. Some highly volatile products of volcanic nature could have combined into chemical compound with solid - lava, for instance, under the effect of solar wind.

Now let's return directly to the surface of the moon in the region of its maria, as it can be seen from the pictures, obtained from the automatic station "Luna-9". You see a solid, more or less even surface, to judge from the line of horizon, slightly wavy. The first impression is of high-mountain stony desert. The main element in the relief of this solid surface of the moon are pits of different sizes, then rock fragments - stones, also of different size, lying on the surface and submerged in the ground. Finally, the most interesting is the uniform surface microsculpture of the lunar maria rocks.

An all-round examination of the pictures, transmitted from "Luna-9", convinces, that in front of you are the areal outflows of basalt lava. Those are not tuffs, which are formed of fragments of rocks, pumice, volcanic glass and ash, etc. They would have had a rougher block structure. The pits are, possibly, relics of the primary relief, for instance, remaining after gas bubbles in lava, etc. The fragments of rocks - stones - were thrown on the surface of lava after its cooling off as a result of explosion of volcanoes or due to impact of meteoritics. But how has the fine surface sculpture of the lunar maria been formed?

The uniformity of the microscuplture indicates regular factors affecting the surface of the lunar maria. It is possible to surmise, however, that the relief, which we see, is a secondary picture, emerged on the surface of the moon under the effect of different factors and processes on the outflown lava, - for instance, considerable fluctuation of the temperature from +100 to -150°C, effect of meteorites impacts. Then the corpuscular, X-ray and ultraviolet irradiation from the sun. Finally, under the effect of chemical reaction of water and gases with hard rock, which undoubtedly took place at least at the moment of separation from the lava of water and other volatile matter. They actively affect the rocks, for instance, by oxidizing them, etc. It may be assumed, that as a result of this peculiarity of processes on the moon we, probably, will encounter minerals new for us. Thus, as a result of sedimentation, i.e. precipitation of matter onto the surface of maria, effect of water, gases there occured formation of the macro- and mesorelief of the moon's maria. The mechnical denudation of the surface imparted uniformity to this process - microsculpture of the surface. Finally, cementation of rock with remains of salts, volcanic ash, meteorite dust have built up the porous, but hard surface of the moon's maria.

Address of A.A. Mikhailov, academician.

Lunar Matter? The Solution is Near.

Looking at the pictures of lunar surface, obtained by the automatic station "Luna-9", it is difficult to believe, that those are photographs, taken not from our terrestrial observatories, but authentic documents, transmitting microstructure of the lunar surface, obtained by a TV camera at the moon itslef. For the first time in the history of mankind it was possible to transfer from the earth operating apparatus to another celestial body. For the first time it was possible to accomplish soft landing, which required enormous accuracy in the braking of automatic station for damping velocity of 2600 m/sec and to bring it down at a prescribed moment to a few meters per second to avoid a destructive impact during the landing on the moon. All this was accomplished and by means of automatic TV camera pictures were obtained, showing with minute details the structure of the lunar surface around the station within a radius of 1.5 km. It is remarkable, that this microrelief resembles thousand times diminished known to us by observations from the earth the general moon relief: here are seen round pits, resembling hilly area close to the south pole of the moon. Apparently, this resemblance between the macro- and microstructure of relief speaks of the common factors, which built up various formations on the moon's surface.

Quite recently there were arguments, as to whether the moon is covered by a thick layer of fine and loose dust, formed as a result of bombardment by meteorites, or if its surface is quite hard. This question was decisive for the possible landing on the moon of a station, which would stand on a solid ground and not get sunk in a deep dust. The majority of our selenographers assumed, that the ground on the moon will hold station's load even of hundreds of kilograms. I remember, how at the International symposium about moon, which took place six years ago in Leningrad at the Pulkov Observatory, our specialist on planets Vsevolod Sharonov, who recently died, demonstrated an artificially obtained a piece of matter, corresponding in its photometric and polarization properties to substance of lunar surface. It was dark, porous, of low weight stone, resembling a piece of slag or tuff, quite strong and capable of withstanding without being crushed quite considerable pressure. Now we know, that this forecast was quite correct and the Sharonov's sample is sufficiently near in its mechanical properties to the real lunar substance.

Quite a lot has already been said about the enormous propsects opens out for astronomists and geophysicists, including meteorologists, for weather forecasting, as well as for geology and cosmogony organisation on the moon of long-acting observatory, the actual possibility of which has now been proved. From the earth, from the bottom of a deep and swelling aerial ocean, we are observing the outer space, figuratively speaking, as though thrpugh a narrow and opaque window. The fluxes of radiant energy reach us in a very limited amount and these are distorted by the restlessness and refraction of terrestrial atmosphere. The absence of air on the moon eliminates all these limitations and distortions. From the moon the cosmos may be observed in all its majesty and variety. The slow axial rotation of the moon and low gravity on its surface will be favorable for construction and the use of lunar observatory, although the great changes of temperature from day to night will create considerable additional difficulties.

With constrvction in 1957 of the first artificial earth satellite begun a new space era of the mankind. Now another important step has been made toward penetration into the immense depths of the universe and resolving its multiple mysteries. In this connection we, the astronomists, frequently recall the negative statement of the French philosopher Ohyust Conte, who wrote in 1830 in his course of positive philosophy, that of necessity the people will never know neither the chemical composition of celestial bodies, nor their mineralogical structure. Only about thirty years have passed since these pessimistic words, when the invention of spectral analysis have pulled down one of these interdictions. Now we are witnessing the downfall of the second interdiction: the mineralogical composition of the moon is no longer a puzzle, and I am sure, that very soon we shall study in our terrestrial laboratories samples of lunar rocks.

In truth, there are no limits to the power of human thought and inventiveness, however for the sake of all humanity these limitless possibilities of science should be directed for the good and not for harm and destruction.

Thereafter, the scientists answered question of the correspondents.

"Pravda", 11th February 1966.

TASS COMMUNIQUE ON THE LAUNCHING OF AUTOMATIC STATION "LUNA-10"

On the 31st of March 1966 at 13 hours 47 minutes Moscow time in accordance with the program of further moon investigation a space rocket was launched to the moon in the Soviet Union.

The rocket carries automatic station "Luna-10".

The station is meant mainly for perfecting systems providing for creation of an artificial moon satellite in order to investigate the circumlunar space, and also perfecting systems for insertion of the station into selenocentric (circumlunar) orbit.

The station is moving along a trajectory close to prescribed.

At 18 hours Moscow time on the 31st of March 1966 the "Luna-10" was at a distance of 51 thousands km from the earth above a point of terrestrial surface with coordinates 33°16' N and 96°6' E.

All the instruments aboard the "Luna-10" operate normally. The Coordination center is conducting processing of incoming information.

"Pravda", 1st April 1966.

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TASS COMMUNIQUE ONE MORE STEP INTO THE OUTER SPACE:

On the 3rd of April 1966 at 21 hours 44 min. Moscow time the automatic station "Luna-10" was inserted into selenocentric (circumlunar) orbit and became first in the world artificial moon satellite.

The insertion of the station into selenocentric orbit was assured by the successfully carried out on the 1st of April, trajectory correction of the station's flight and precisely accomplished maneuver on its approach to the moon on commands from the earth.

The following are the orbital parameters of the first artificial satellite of the moon:

- minimum distance from the moon's surface (at periselenium) - about 350 km;
- maximum distance from the surface of the moon (at aposelenium) - about 1000 km;
- orbital period of the station around the moon- about 3 hours.

Aboard the first artificial moon satellite are instruments for investigating the circumlunar space.

Data of scientific measurements are being transmitted by means of telemetric system to the earth. Flight tracking of the artificial moon satellite and measurements of its orbital parameters is being conducted by the center of distance space communication.

The insertion of the first artificial moon satellite into lunar orbit is a new outstanding victory of Soviet scientists, engineers and workers. Our country, which has constructed in 1957 the first artificial earth satellite, today placed the first artificial moon satellite into a lunar orbit, which is an important stage in the moon's investigation.

"Pravda", 4th April 1966.

TO THE XXIII CONVENTION OF THE COMMUNIST PARTY OF THE SOVIET UNION:

The Unions of scientists, designers, engineers, technicians and workers, who participated in construction, preparation and launching of the automatic station "Luna-10", are happy to inform the XXIII convention of our own Communist Party, that yet one more assignment of the Party and the Government on the mastering of space has been implemented.

For the first time in the world the Soviet automatic station "Luna-10" was successfully placed into circumlunar orbit and became the first in the world artificial moon satellite.

Just as all the Soviet people, we are proud, that the first artificial moon satellite, same as the first artificial earth satellite, was constructed and launched by the Soviet union - our great socialist state. By the insertion of the automatic station "Luna-10" into a circumlunar orbit the most difficult scientific and technical problem has been resolved and a new page opened in the conquering of moon.

We, the participants in creation of the first artificial moon satellite, dedicate this achievement in the mastering of space to the XXIII Convention of the Communist Party of the Soviet Union.

Our Unions, as the entire Soviet People, watch with great attention deliberations of convention, which is examining the fundamental questions of the development of socialist motherland, marks projects of further Communist build-up.

We assure the delegates of the XXIII Convention of the Lenin' Party, that scientists, designers, engineers, technicians, workers will henceforth also give all their knowledge and efforts to the noble endeavor of peaceful mastering of the outer space for the glory of our motherland, for the good of all mankind!

Scientists, designers, engineers, technicians
and workers, participating in construction and
launching of the automatic station "Luna-10".

To scientists and designers, engineers, technicians and workers, all Unions and Organizations, taking part in construction and launching of the automatic station "Luna-10".

Dear Comrades!

Our socialists motherland continues successfully peaceful mastering of the outer space.

On the 3rd of April 1966 for the first time in the world, automatic station "Luna-10" was inserted into circumlunar orbit and is conducting investigations in direct vicinity of the moon. The creation of the artificial moon satellite is a new outstanding achievement of the Soviet science and technique, a most important contribution to the world science.

Investigations of the moon by means of the automatic station, inserted into circumlunar orbit is one more step in the mastering of space, naturally connected with the growth of our motherland's might, with the flourishing of creative power of the Soviet People. The Soviet people are proud of the fact, that this station was created in our country by the talent and labor of Soviet Scientists, designers, engineers and workers, who resolved the most difficult scientific and technical problems.

The new victory in space investigations proves the successful accomplishment of tasks according to plan, set by the Party and the Government to the scientists, designers, engineers and workers. Your report on this outstanding achievement was received with high satisfaction by the delegates to the XXIII Convention of the CPSU.

Delegates to the XXIII Convention of the Communist Party of the Soviet Union, our Party, the entire Soviet People sincerely congratulate scientists and designers, engineers, technician and workers, Unions and Organizations participating in development, construction and launching of the first artificial moon satellite.

Glory to the Soviet people - the builder of communism, mainly fighter for peace and happiness of all peoples!

Long live Lenin's Communist Party of the Soviet Union - the inspirer and organizer of all the victories of the Soviet people.

Presidium of the XXIII Convention
of CPSU.

"Pravda", 4th April 1966 (Special edition).

"LUNA - 10" IN ORBIT AROUND THE MOON:

Only two months have passed since the day of accomplishment of the grandiose experiment soft landing of the automatic station "Luna-9". And again the attention of the whole mankind is riveted on the moon. On the 3rd of April at 21 hours 44 min., Moscow time the Soviet automatic station "Luna-10" came out into orbit of the artificial moon satellite. For the first time in history a man-made space vehicle is orbitting around the moon.

The creation of the artificial moon satellite is a necessary stage in the mastering of the outer space. The artificial earth satellites have helped to raise the curtain on many mysteries of nature. Today there are hundreds of artificial satellites in the circumterrestrial orbit, assisting people in accomplishment of radio-communication and TV transmission through space, correct weather forecasting and to conduct extensive meteorological investigations. The artificial earth satellites have enabled to obtain a number of most important data about the circumterrestrial space, to detect the radiation zone of the earth, extensively investigate the magnetic field and ionosphere of our planet, corpuscular radiation of the Sun and cosmic rays.

Many scientific problems, connected with the nearest to the earth cosmic body - the moon, could be resolved by direct study with the help of the artificial moon satellites. The program of scientific investigations, being conducted with their help, will make it possible to expand considerably our knowledge of the moon and circumlunar space.

Launchings of the artificial moon satellites will make it possible to resolve a number of scientific and technical problems, bound with improving methods of the spaceship control in its insertion into circumlunar orbit, investigation of the radio-sets performance close to the moon to determine evolution of the vehicle's orbital parameters, and to carry out widespread investigations of the physical properties of the moon and cicrumlunar space.

One of the interesting problems is the investigation of meteoric environment in the space near the moon. Measurements, carried out by the artificial earth satellite, have shown, that in circumterrestrial space at various altitudes there is irregularity inthe distribution of meteoric matter. So far it is unknown, how the meteoric particles are distributed near the moon.

The meteor showers may constitute great danger for space vehicles. Moving at velocities of some tens of kilometer per second, meteoric particles are capable of great destruction. Although the probability of encountering even insignificantly small meteors is not high, nevertheless for ensuring complete safety of the spaceship's flight it is necessary to extend our knowledge on composition and variation of meteor showers.

Another important problem - determination of the thermal characteristic of the moon. The earth atmosphere in the infrared part of the spectrum has a small "transparency window", through which there is penetration of radiation with wavelength from 8 to 12 microns. Therefore it is only within the limits of this "window" that the measurements can be made of the thermal radiation flux of bodies, outside the earth's atmosphere. But the width of the "transparency window" is inadequate for studying the total thermal spectrum of the moon.

It is a known fact, that the moon's temperature varies in a wide range. As soon as the sun rises above the lunar horizon, surface temperature begins quickly to rise. At noon the Moon's surface in the equatorial area gets heated upto 100-130°C. After the sun has set the moon's surface quickly cools off and its temperature drops to - 120°C.

A more detailed study of the moon's thermal characteristics at a close distance, when the measurements are not distorted by the earth's atmosphere, will enable to resolve one of the important questions, connected with the moon's investigations.

The magnetic field of the moon has been investigated by means of space rocket "Lune-2", launched in September 1959. These investigations have shown, that the moon's magnetic field is insignificant, the intensity of which is not above one thousandth of terrestrial field. Further verification of the intensity of the moon's magnetic field by means of a more sensitive magnetometer is of high significance for elucidating the nature of magnetism in various celestial bodies.

One of the most interesting scientific problems is determination of the gravity field of the moon. The astronomic methods enabled to determine the moon's mass, but the finer characteristics of the gravity field are known at present only approximately, since for their determination the use has to be made of various unconfirmed hypotheses. Orbital parameters measurements of the artificial moon satellites for a prolonged period enable to follow the evolution of the orbit. Since the nature of the orbital evolution depends on the irregularity of the gravity field, it will be possible by direct methods to estimate the difference of the moon's gravity field from spherically symmetrical. This experimental study of the moon's gravity field has an important scientific significance.

All these problems are of great interest to science:

Composite investigations of circumlunar space and the moon's surface by means of artificial satellites and automatic stations of the type of "Luna-9" will provide a great amount of information on various scientific aspects of the earth's nearest neighbor.

The initial flight of the automatic station "Luna-10" resembles the flight of other automatic stations. It was placed on circumterrestrial orbit, from which it started to the moon. However, the flight path was guided not at some point of the moon's surface,but at a point, 1000 km from the moon.

The flight path of the lunar spaceship shows two parts:

- flight path in the action sphere of the earth, where the gravity attraction of the earth is higher than the lunar gravity;
- flight path in the sphere with predominance of lunar attraction.

The moon mass is considerably less than the earth mass, therefore the activity sphere of the moon is less than the activity sphere of the earth. The activity sphere of the moon extends for about 60-70 thousand km. from its center and is within the activity sphere of the earth. With the start from intermediate or t of earth satellite the boost cluster provided "Luna - 10" with velocity of about 10.87 km/sec.

With this initial velocity the flight time to the moon composed a little less than three and a half days. With entry into lunar activity sphere the station's velocity was about 1 km/sec. in relation to the moon.

In order to ensure the insertion of station into prescribed lunar orbit, trajectory correction was carried out from the results of radio-measurements. As a result the station entered into flight trajectory, passing at prescribed distance from the lunar surface.

Moving in accordance with celestial mechanics, the automatic station picks up in the lunar area velocity of about 2.1 km/sec., and if this velocity is not decreased, the station will leave the moon and get converted into an earth satellite. Thus, to place the station into lunar orbit and convert it into lunar satellite the flight velocity of the automatic station has to be reduced to about 1.25 km/sec. at some previously determined point of the lunar space.

These conditions are assured by a special radio-system and corresponding flight control complex.

During the preceding flights the trajectory control system, radio-set aboard, astro-orientation system and automatic control devices were perfected in natural conditions.

The automatic station"Luna-10" consists of the two main sections; lunar satellite, which is being placed into the lunar orbit, and propulsion system with instrumental compartments.

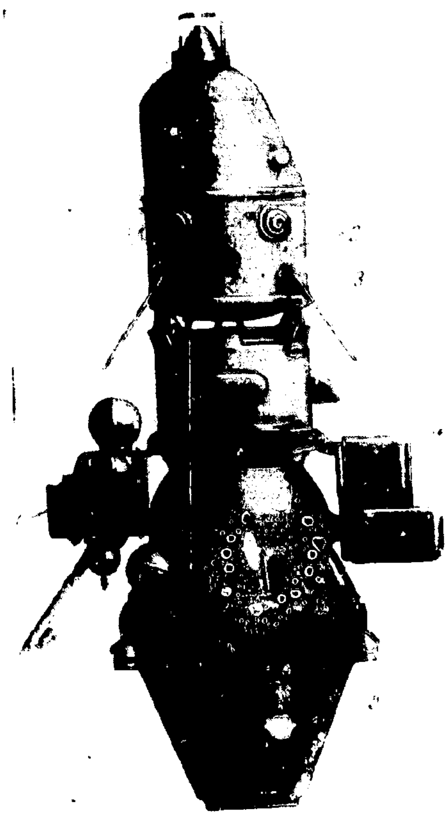

Figure 17: Automatic station "Luna-10".

1- Measuring radio-system.
2- Lunar satellite;
3- separation device of lunar satellite;
4- astro-orientation system;
5- propulsion system;

After the insertion of automatic station into lunar orbit the lunar satellite is separated by a special device from the propulsion system and begins to carry out scientific investigations.

The lunar satellite is a hermetically sealed container 245 kg in weight. It carries the following equipment:

- radio set, telemetric system, programming-timer units;
- Scientific instruments for the moon and lunar space investigations;
- thermal control system;
- antennas;
- power-supply sources.

The propulsion system of automatic station consists of jet engine, fuel tanks, fuel delivery manifold, control members, required for stabilization of the vehicle in flight during engine operation.

The propulsion system is used for trajectory correction and deceleration for transfer into the lunar orbit.

In instrument compartments are the flight control system and orientation system, consisting of gyroscopic instruments, electronic optical devices and programming timer units. In the same compartments are the power supply sources, telemetric control system and micro-rockets of the orientation system.

The control system assures stabilization of the automatic station about the gravity center, issue of commands for cut-in and cut off of engines. Stabilization of the automatic station is implemented by means of micro-rockets.

The weight of automatic station "Luna-10" after insertion into lunar trajectory composed 1600 kg. Its flight diagram is shown in Figure 18.

Initially the automatic station and boost cluster were placed into orbit of earth satellite. This orbit has the following parameters:

- altitude at perigee 200 km;
- altitude at apogee 250 km;
- orbital inclination about 52°.

Thereafter the station was transferred to lunar trajectory. According to obtained forecast the actual movement of "Luna-10" was somewhat different from the prescribed. Therefore the command and measuring complex prepared primary data for the trajectory correction.

The command for correction was issued from the earth during one of the communication periods. The primary data for correction were preliminarily transmitted aboard the station. The subsequent work of all the systems was automatic.

As a result of correction, carried out on the first of April, the velocity of the automatic station "Luna-10" changed to a prescribed amount. The ground control measured parameters of the corrected flight trajectory of the automatic station. Calculations have shown, that the path after correction passes practically through prescribed point. From the parameters of trajectory after correction primary data were determined for deceleration in order to transfer the station into lunar satellite orbit. These data were transmitted to the station.

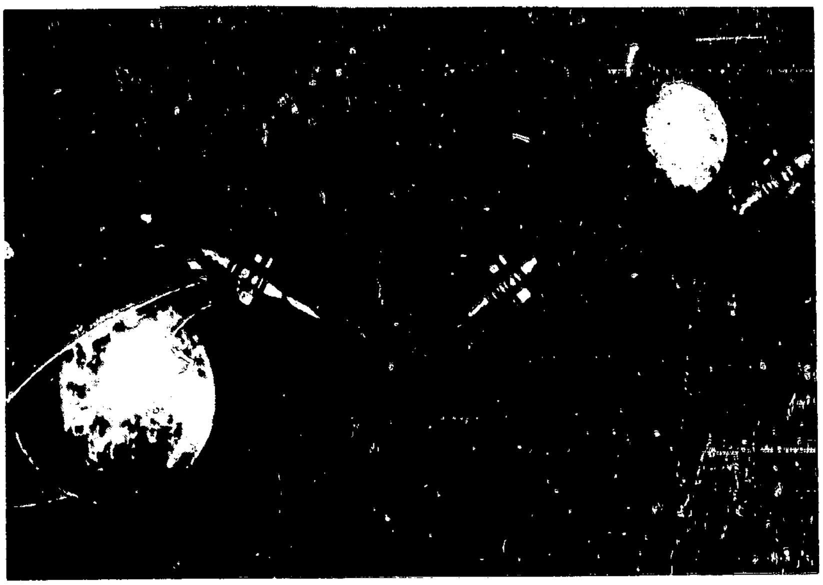

Figure 18: Flight diagram of the automatic station "Luna-10".

1- circumterrestrial orbit; 2- Lunar trajectory correction; 3- orientation of the station prior to deceleration; 4- deceleration and entering into earth satellite orbit.

Earlier, approximately at 2000 km from the lunar surface, the station was oriented in a way, that at the moment of reaching near the moon the jet nozzle would be directed against the flight (see figure 19).

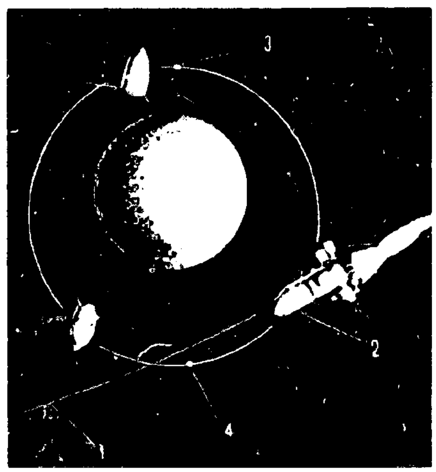

Figure 19: Insertion of lunar satellite into orbit.

1- flight path; 2- cut-in point of braking rocket; 3- pericynthion; 4- apocynthion.

Approximately at [illegible] hours [illegible] minutes the control system gave a signal for the cut-in of braking motor. After the cut-off of engine the velocity of the station dropped from 2.1 to 1.25 km/sec. Reduction of velocity of the station assured its transfer into lunar satellite orbit with the following parameters:

- distance at apocynthion about 1000 km,
- distance at pericynthion about 350 km;
- orbital period about 3 hours.

20 seconds after brake engine cutoff the control system gave a signal for separation of the lunar satellite from the propulsion system and control system compartments. The separating device operated normally. Thereafter begun the first radio-communication with the lunar satellite. This has shown, that devices operate normally, thermal control system provides the required conditions, radio-communication with the station steady.

The creation of lunar satellite is an outstanding even in the history of space conquest, one more step in the development of human knowledge. And it is specially joyful and pleasant, that the way into space is being laid by Soviet man, who successively step by step goes first in the world along the hard road of understanding the Universe.

IN CIRCUMLUNAR ORBIT. FIRST SCIENTIFIC RESULTS OF THE "LUNA - 10" FLIGHT:

On the 3rd of April 1966 the automatic station "Luna-10" was placed into lunar satellite orbit. With the creation of the first in the world artificial lunar satellite begun a new stage of direct investigation of the moon's physical properties and of lunar space.

Station "Luna-10" carries the following scientific instruments:

- three-component magnetometer for verifying lower limits of the possible magnetic field of the moon;

- gamma-ray spectrometer intensity and spectral composition investigation of the lunar surface gamma-radiation;

- countries for recording solar corpuscular and cosmic radiation, as well as for the investigation of low-energy electrons in order to determine the lunar ionosphere and study of charged particles in the "tail" of circumlunar magnetosphere of the earth;

- ion traps for recording total ion and electron flux of solar wind and the search for lunar ionosphere;

- piezoelectric pickups for recording in the inter-planetary and lunar space of meteoric particles with mass over one hundred millionth of a gram;

- infrared detector for determination of integral thermal radiation of the moon;

- counters of low-energy X-ray photons for measuring X-ray fluorescent radiation of rocks on lunar surface.

As we know, in 1959 by means of Soviet space rocket "Luna-2" it was shown, the magnitude of the lunar magnetic field does not exceed one thousandth of the earth magnetic field. This was the first experimental investigations of the moon's magnetic properties.

The sensitivity of magnetometer on the Station "Luna-10" is fifteen times higher than of the one of "Luna-2". This permits to estimate more precisely the intensity of magnetic field surrounding the moon.

The preliminary analysis of carried out measurements has shown, that on the 5th of April the magnetic field intensity was within 15-20 gammas and varied little at various orbital points.

The measured intensities of the lunar field is slightly higher than the level of magnetic field in the free interplanetary space during the period of magnetic calm. However, so far it cannot be asserted, that it is connected with the presence of the self-magnetic field of the moon.

It is well known, that continueus flux of particles - "solar wind" is coming from the sun. As a result of interaction of the solar wind with magnetic field of the earth it becomes considerably deformed, and the force lines of the field extend opposite to the sun, forming the so-called magnetic tail of the earth.

If magnetic tail of the earth extends to lunar orbit, th n during the first measurements the station "Luna-10" was within the magnetic tail of the earth, and this could have specified the higher intensity of magnetic field. Hence the moon will be out of the magnetic tail region. Measurements of extra magnetic tail will make it possible to decide, whether intensity variations of magnetic field are caused by the lunar magnetic field or by the magnetic tail of the earth.

Study of the first results of measurements, conducted by means of the charged particles traps, permits to draw a preliminary conclusion, that in sections of flight between the earth and the moon and in the lunar satellite orbit the flux was recorded both of negative and positive particles (including low-energy ions).

Counters of cosmic radiation recorded cosmic background between the earth and the moon. The cosmic backgroundis at present slightly high (5 particles per sq.cm/sec), as was to be expected during the period of the minimum solar activity.

Data were obtained on lunar orbit, which could be interpreted as the presence in lunar space of a flux of electrons with energy of tens of thousands electron-volts. In their intensity these fluxes exceeds the cosmic background

70-100 times. It is possible, that this is caused by the magnetic tail of the earth. The subsequent measurements will enable to draw more definite conclusions regarding the radiation environment in the vicinity of the moon.

The"Luna-10" has transmitted spectra of gamma-radiation, obtained above different areas of lunar surface. In this case a higher intensity was detected of gamma - radiation, specified mainly by the interaction of cosmic rays with surface layer of lunar matter. According to primary data, the level of natural radioactive radiation of lunar rocks, connected with the radioactivity of uranium, torium and potassium, in comparison with the similar radio-activity of the earth rocks approximates that of the basal rocks - basalts.

Piezoelectric pickups are attached on the sheeth of the station. Area, sensitive to impact of meteoric particles, composed about 1 sq.m. According to primary data, the spatial density of meteoric particles within the lunar satellite orbit is higher, than in the intre-planetary space.

The infrared detectors is made up of two radiation receivers, which are flat plates placed next to each other.

The first data were obtained and are being processed on thermal and fluorescent radiation of the lunar surface.

The scientific station "Luna-10" first in the world lunar satellite-continues its investigations.

"Pravda", 10th April 1966. (TASS).

A GREAT LANDMARK IN SPACE INVESTIGATIONS:

PRESS-CONFERENCE ON THE FIRST SOVIET LUNAR SATELLITE:

Yesterday a press-conference was held in the Moscow Club of Scientists, dealing with the launching of the Soviet automatic station "Luna-10", the first in the world lunar satellite. In the conference room of the Club - Soviet and foreign journalists, scientists, workers of various departments in the Capital.

The bright light of "jupiter" lamps illuminates those present, the whirring of cine-cameras is continuous, there is clicking of photo-cameras. Press-conferences, dedicated to successive victories of the Soviet conquerors of space, have since long become events of great significance, as every time they mark one more historical stage of understanding the infinite depths of the Universe.

Since 1959 lunar flights have begun in the Soviet Union of space rockets. In January 1959 the first space rocket passed close to the Moon and entered a planetary orbit of the Solar System. In September 1959 the automatic station "Luna-2" reached lunar surface and carried out first physical measurements. In October of the same year station "Luna-3" have orbited the Moon and for the first time transmitted to earth TV pictures of the major part of the other side of the Moon. On the 18th July 1965 an automatic interplanetary station "Zond-3" was launched, which, passing close to the Moon, completed shooting of its other side and made it possible to obtain highly detailed pictures.

On the 3rd of February 1966 the Soviet space station "Luna-9" soft-landed on the lunar surface close to equator on the eastern edge of the Oceanus Procellanum and transmitted to the earth pictures of the lunar landscape, visible directly from the Moon. The soft landing was the most important step in the development of cosmonautics and opened out enormous possibilities for the science. The creation of the first lunar satellite is a new step, opening out future prospects in the study and mastering of the moon. Soft landing and lunar orbiting provide the possibility of an al-round investigation of the moon.

The accomplishment of soft landing and insertion of the space vehicle into lunar satellite orbit required resolution of composite scientific and technical problems. High precision was required for placing the space station into lunar trajectory, to assure flight control, exact orientation from the celestial luminaries and to carry out by means of the brake rocket engine the exact deceleration at the moon.

With soft landing the flight path is guided into the center of the moon and deceleration has to be to zero velocity directly at the lunar surface. Whereas with the insertion of space station into the lunar satellite orbit the flight path by-passes the moon and at the prescribed point the brake rocket engine reduces velocity of the space vehicle, transferring it into elliptical lunar orbit. To obtain an orbit close to prescribed very high accuracy was required of the orientation, control system and propulsion system. The station "Luna-10" was placed into orbit with a minimum distance from the moon 350 km and maximum 1000 km. The orbital plane was initially at an angle of 72° to the lunar equatorial plane. Orbital period of the satellite - 2 hrs 58 min.

In creation of satellite the required decelerative force is lower than in landing. This permits to increase considerably the useful weight in the lunar orbit and to set up devices for a whole series of the most important investigations of the moon and the lunar space.

Absence on the moon of the atmosphere permits study from the lunar satellite of many properties of the lunar surface by recording gamma, X-ray, fluorescent and infrared radiation. Important information regarding the lunar gravity field will be provided by observing evolution of this satellite's orbit.

The space station "Luna-10" is equipped with a large set of scientific instruments for verifying the intensity of the possible lunar magnetic field, chemical composition study of the lunar surface, radiation conditions in lunar space and investigation of other important scientific aspects.

Incoming regularly from the station "Luna-10" is the telemetric information. There was a period of radio setting, when the station, emitting unmodulated radio-signals, entered behind the moon.

The measurements and transmission of scientific information are continuing. The first data have already been obtained on the rock composition of lunar surface, radiation conditions in lunar space, magnetic effects and density of meteoric matter and plasma in the vicinity of the moon.

Total flux measurements of heat radiation, to which the earth's atmosphere is impervious, except for a small spectral interval, make it possible to verify our knowledge regarding temperature and radiation capacity of lunar surface. By measuring X-ray-fluorescent radiation of the lunar surface, which, apparently, was possible to record, the scientists' hope to conduct mapping of the type of lunar rocks from their chemical composition.

From aboard the station "Luna-10" - lunar satellite - the melody was heard of our Party anthem "International".

The creation of lunar satellite opens out many new possibilities for the science.

Inaugurating the press-conference, on creation and launching of the first lunar satellite - space station "Luna - 10", M.V. Keldysh invites A.P. Vinogradov to take the floor.

FIRST INFORMATION ON THE LUNAR GROUND:

Radio-activity determination of rocks, composing lunar surface, is of exceptional interest from many points.

Firstly, it is important for resolving a number of problems, connected with the origin and evolution of the moon. Their resolution is impossible without the knowledge of the chemical composition of lunar rocks and their radio-activity.

Investigation of the moon's radio-activity is of interest also from another point. Due to absence of the lunar atmosphere cosmic radiation freely reaches lunar surface. With the interaction of cosmic rays with the lunar rock there are nuclear reactions. Therefore, we should expect the existence on the lunar surface of radio-activity, induced by cosmic rays, practically non-present on the earth due to the protective effect of the earth's atmosphere. The investigation of this radio-activity makes it possible to draw a number of interesting conclusions regarding the intensity and energy composition of cosmic rays in the vicinity of the moon, their variations in the past, about the effects, caused by radiation, generated with flares on the sun, etc.

Finally, the intensity and spectral composition study of gamma-radiation provides important from the viewpoint of the future practical mastering of the moon information regarding radiation conditions on its surface.

As a geochemist, I shall deal in more detail with the geochemical side of results, obtained from the automatic station "Luna-10".

Radio-activity of earth rocks is determined by the presence in them of radioactive elements, i.e., of uranium, torium and potassium-40. The richest in radio-active elements are the granites, widespread in continents. Basalts, which form on our planet a solid basalt layer within the earth crust, contain radio-active elements at least 10 times less, than the granites. As we know, the basalts have originated as a result of splitting, under the radiogenic heat, of the planet's primary matter, close in composition to stony meteorites, which separated into basalts and ultrabasic rocks. Basalts, as the more fusible, were melted out onto the earth's surface. The ultrabasic rocks, which lie, as a rule, beyond the earth crust and belong to the earth's mantle (i.e. to transitional layer of earth), contain radioactive elements about 100 times less, than the basalts. The stony meteorites are of the same group as basalts in content of uranium, torium and patassium-40.

Thus, granites, basalts, ultrabasic rocks and stony meteorites, distinct in properties and chemical composition, differ considerably also in the content of radioactive elements. In other words, quantity determination of radioactive elements in uranium, torium and potassium-40 in rocks provides at the same time the idea also of the type of these rocks.

There are most various concepts regarding the nature of lunar rocks. Thus, for instance, it is assumed, that rocks covering the lunar surface, probably, resemble the crystalline rocks of the earth crust. On the other hand, there is opinion, that the lunar surface is composed partially of the remains of large meteorite bodies, which have fallen on the moon in distant past, i.e., of ultrabasic meteorite matter, etc. The range of these concepts is quite wide.

The experiment set up by means of the automatic station "Luna-10", for the first time has given into the hands of scientists exceptionally interesting experimental material from direct investigations of the radio-active nature of lunar rocks.

According to primary estimates, the content of the natural radio-active elements in the lunar rocks lies within the region of the earth's basalt rocks.

We don't feel so far like giving any extensive conclusions and prefer to collect and process the whole of the enormous material incoming from the station "Luna-10". However, even now the conclusion comes involuntarily, that, apparently, the processes of crust formation for the planets of earth group have one and the same mechanism.

The micrometeoric setting in the circumlunar space was also investigated by means of the station "Luna-10".

From the 3rd to 12th of April the recorder of meteoric particles in lunar orbit was exposed for several periods with total time 5 hrs 16 min. During this time 53 impacts were recorded of meteoric particles. If we take average number of impacts per square meter per second during the exposure time, it will exceed the average number of impacts in the interplanetary space 100 times.

At present it would be premature to draw any conclusions in regard to observed phenomena. To judge wheather the moon passes through concentration, similar to concentrations, observed in the interplanetary space, or if this concentration is inherent to the moon, will be possible later, after additional data have been obtained and experimental material accumulated.

The speaker is Prof. N.L. Grigorov.

MAGNETIC FIELD, IONOSPHERE, RADIATION:

The physical characteristics of the lunar space are only partially determined by the physical characteristics of the moon itself. There is a considerable influence in the measured parameters not only of the sun, but in some case also of the earth. For instance, the magnetic fields in the vicinity of the moon could be the sum of magnetic fields of the moon, magnetic fields of the solar corpuscular flux and magnetic field of the earth.

Naturally, in these conditions separation of the physical parameters of the lunar space, specified by the moon itself, presents considerable experimental difficulties.

In order to separate reliably the physical characteristics of the lunar space of specific lunar origin, the investigations have to be conducted during various periods of solar activity, in different positions of the sun, the earth and the moon.

The study of lunar space, conducted in 1959 by means of "Luna-2", has shown, that magnetic field of the moon, if it exists, is not above 50 gammas in intensity; that the stable level of the captured radiation, if it exists, is at least 1000 times lower, than the radiation level in terrestrial radiation zones. Thus, as the physicists say, the upper boundary was fixed of the possible values for a number of most important parameters determining the properties of the lunar space.

To make any progress in these investigations, it was necessary to use scientific devices of a higher sensitivity, than those used in preceding measurements.

The measurements of magnetic field in the vicinity of the moon began on the 3rd of April after the entry of "Luna-10" into lunar orbit. The reading of all three channels of the "Luna-10" magnetometer clearly define the presence of a weak uniform and regular magnetic field. From the results of preliminary processing the intensity modulus of the field composed on the 3rd of April 14 gamma, on the 5th of April - 24 gamma, on the 8th of April - 18-36 gammas. On the 9th of April the mean intensity of the field composed 17 gammas.

In comparing intensities of magnetic field, obtained during the period from 3rd to 9th April with changes in position of the moon in relation to the earth-sun line the attention is drawn to the fact, that the angle moon-earth-sun was almost 180° between the 5th and 6th April, when during the longest period of communication the field's intensity was maximum.

The observable weak magnetic field in the vicinity of the moon during the full-moon period could be caused, as mentioned, by three different reasons. It could be the inherent lunar field, interplanetary magnetic field of solar origin and the "tail" of the earth's magnetosphere.

Keeping in view the magnetic calm during the indicated period, the observed gradual intensity variation of magnetic field from day to day is, possibly, connected with the changes of the moon's position in relation to the sun-earth-line. This nature of the magnetic field variation should be expected, if the "tail" of the earth magnetosphere reaches the lunar orbit. The role of magnetosphere "tail" in these measurements could be verified by measuring magnetic field during the new-moon period.

It is well known, that the moon does not have a dense atmosphere, but the existence is not excluded of a very rarefied atmosphere. If the moon has atmosphere, the ionized by solar radiation atoms of the lunar atmosphere should form the lunar ionosphere. Therefore a lot of attention was paid to experiments on "Luna-10", which could resolve the question about the existence of the lunar ionosphere.

With the object of direct density measurements of ions in lunar space a charged particles trap was set up on the "Luna-10" of modulation type, which enables to record positive ions with energies less than 10 electron-volts.

The analysis of measurement results permits to draw a preliminary conclusion, that on the lunar orbit the recorded flux is of low-energy ions.

The "luna-10" carries also two four-electrode traps, which permit to record total flux of ions with energies over 50 electron-volts.

The search for lunar ionosphere was conducted also by studying variation nature of radio-signals during the entry of satellite behind the moon. Observation of radio-setting was conducted on the 8th of April. The power level of received radio-signal was recorded by special device. Power decrement of radio-signal with setting and increment, when "Luna-10" came out from behind the moon were clearly recorded by self-recorders. The processing of obtained recording has shown, that the law of decline and rise of signal level corresponds to diffraction of radio-waves on a sharp edge of the lunar surface without noticeable distortions, which would have been observed with the presence on the moon with noticeable gas medium, absorbing or refracting radio-waves.

For the study of radiation environment in lunar space, two counters of charged particles were set up on the "Luna-10".

Study of the weakly-penetrating r. iation has shown, that during the full-moon period, between 5th and 6th April, the level of this radiation was minimum. Thereafter, with the exit of the moon from the assumed "tail" of the earth's magnetosphere, the intensity of radiation increased and reached maximum on the 9th of April. In this case the count rate exceeded 10-20 times the level of the backgr ,und, specified by the particles of cosmic rays.

If the radiation level, recorded on the 5th and 6th of April, is taken as due to captured radiation by assuming the existence of time-stationary radiation zone of t. ˋ moon, the intensity of particles in it will be 100,000 times lower, than in the radiation zones of the earth.

In the measurements of various physical parameters the attention is drawn to the fact, that both the intensity of magnetic field and the concentration of positive ions, as well as the intensity of radiation were found to be dependent on the moon's position in relation to the sun-earth line. It is possible, that in further analysis of the whole combination of obtained information the internal bond between these phenomena will be elucidated.

The speaker is A.A. Mikhailov, academician and well-known astronomist.

WHAT IS IT LIKE, OUR COSMIC NEIGHBOR:

The launching of the lunar satellite is of enormous scientific significance. The lunar satellites, equipped with corresponding devices, will be able to provide an exact information on many quite unknown or still insufficiently known properties of the moon and lunar space. These include investigations of the thermal conditions on the moon, possible volcanic activity, concentration of meteorites in lunar space, lunar magnetic field, its inherent radiation and reflecting properties in infrared and far ultraviolet rays, direct photographing and TV transmission of lunar surface pictures, etc.

Of special importance is the fact, that the inclination of the satellite orbital plane to the lunar equatorial plane composes 72°. The fact is, that the orbital plane of the satellite retains invariable direction in the space, whereas within the orbit the moon is rotating, completing revolution about its axis during a lunar month in 27.3 days. As a result the satellite after every revolution shifts along the lunar longitude by 1.6°. During a month the satellite flies twice above each point of lunar surface.

But besides the physical investigations the existence itself of the satellite in the orbit is extremely important. Radio-technical orbital parameters measurements of lunar satellites permit to obtain most valuable information. First of all the moon's mass will be verified or, better to say, mass ratio of the earth and the moon, which is taken at present as 81.30. Another interesting question is about the mass center of the moon itself. Investigation of the moon's orbiting around the earth has shown, that the mass center does not coincide with the center of the visible lunar disc, but is displaced approximately by 1 km north from the center of disc.

Next the scientist was speaking about the significance of lunar satellite for confirming its figure.

Thereafter the scientists answered questions of the Soviet and foreign journalists.

"Pravda", 17th April 1966.

TASS COMMUNIQUE "LUNA-10" COMPLETED PROGRAM OF SCIENTIFIC INVESTIGATIONS:

The Soviet automatic station "Luna-10" - the first lunar satellite - has successfully completed the program of scientific investigations.

219 communication periods were carried out with the station, during which a great amount of scientific information and trajectory determinations was obtained.

The last communication was on the 30th of May 1966; thereafter the communication with the station has ceased, since the energy reserve of current sources on board was totally exhausted.

During its active existence the station completed 460 revolutions around the moon, having flown over seven million kilometers.

At present the obtained material is being processed. The results will be published in the press.

"Pravda", 3rd June 1966.

TASS COMMUNIQUE IN SPACE - "LUNA-11":

In accordance with the program for further investigation of the moon and lunar space a moon shot was implemented in the Soviet Union on the 24th of August 1966 at 11 hrs. 03 min., Moscow time. The rocket carried automatic station "Luna-11" weighing 1640 kg.

The main object of the station is further perfecting of the lunar satellite systems and scientific investigations in the lunar space.

The preliminary processing results of measurements indicate, that the station's trajectory is close to prescribed. At 14 hrs Moscow time on the 24th of August 1966 the station "Luna-11" was 26 thous. km. from the earth, above a point of terrestrial surface with coordinates 12°4' N and 135°50' E.

According to telemetric data, the instrumentation aboard the station functions normally.

Tracking of the station is being implemented by a special measuring center on the ground. The coordination center is conducting processing of the incoming information.

"Pravda", 25th August 1966.

"LUNA-11" TRANSMITS:

In accordance with investigation program of the outer space, automatic station was insterted into lunar orbit on the 28th of August 1966 at 00 hrs 49 min Moscow time. The new Soviet lunik is designed to continue scientific investigations of the moon and lunar space, begun by preceding luniks.

The automatic station "Luna-11" is a composite space vehicle. The air-tight containers carry control and astro-orientation systems, radio equipment, scientific instruments, thermal control system, power-supply sources and other devices. On the body of the automatic station are the receiving and transmitting antennas, portion of the scientific instruments, not requiring hermetization, active units of astro-orientation system.

The flight path of the station "Luna-11" has a lot in common with that of the station "Luna-10". Initially by means of carrier-rocket a heavy earth satellite was placed into earth orbit. Then the space rocket took-off from the heavy satellite and placed the station into lunar trajectory.

In approaching the moon, when the station was at 8000 km from its surface, the orientation system, using bearing on the moon and the sun, oriented the station exactly vertically to lunar surface. The swing of the station at required angles was implemented by micro-rockets. A special system memorized this direction as bearing and turned the station additionally at a required angle, so that the engine may take up the required direction at the start of deceleration. This position was retained by the system till the cut-off moment of propulsion system after the braking of the station.

The primary data for braking in order to transfer the station into lunar orbit were transmitted by radio. At 00 hrs 49 min on the 28th August the automatic station transferred from the flight path to lunar satellite orbit of the following parameters:

- minimum distance from lunar surface - about 160 km;

- maximum distance from lunar surface - about 1200 km;

- orbital inclination - about 27 degrees;

- orbital period about 3 hours.

The first radio-communication with lunar satellite has shown, that the apparatus operates normally, thermal control system provides the required conditions, radio-communication with the station steady.

The set of scientific instruments aboard the automatic station permits to conduct various investigations and experiments. Gamma - and X-ray radiation of lunar surface are being investigated by means of devices. This will enable to verify the chemical composition of the lunar rocks. From the measurements of orbital evolution the characteristics will be confirmed of the lunar gravity field. A special device measures X-ray fluorescent radiation of the lunar surface with the object of determining chemical elements, contained in the lunar ground. An important characteristic of the lunar space are the concentration of meteoric fluxes and their distribution, as well as the intensity of the hard corpuscular radiation in the vicinity of the moon. Special devices on board the station investigate these physical phenomena.

Similar investigations were conducted by automatic station "Luna-10". But its orbit was inclined at 72°. The new lunar satellit implements these measurements in plane, close to equatorial. Moreover, the scientific devices aboard the new satellite are slightly changed in view of the results, obtained by measurements from the "Luna-10". The analysis of new data and their comparison with the previous will make it possible to clarify various physical properties of our natural satellite. The "Luna-11" carries radio-astronomical instruments, observing the long-wave cosmic radio-emission.

The scientific investigations, being conducted by the new Soviet lunar satellite, open out the furthest prospects for the study and mastering by mankind of the Universe space.

"Pravda", 28th September 1966.

TASS COMMUNIQUE "LUNA-11" HAS SUCCESSFULLY COMPLETED ITS PROGRAM

As communicated previously on the 28th August 1966 a second Soviet lunar satellite "Luna-11" was placed into selenocentric orbit.

The objects of the station were; further improvement of methods for insertion of the station into lunar satellite orbit and continued scientific investigations of the lunar space, begun by preceding Soviet automatic stations.

On the 1st of October 1966 the automatic station "Luna-11" completed the program of scientific investigations. Since the 28th of August 137 sessions of radio-communication were carried out with the station, during which a great amount was received of scientific information and trajectory measurements.

During its active existence the second Soviet lunar satellite completed 277 revolutions around the moon.

The last session of radio-communication with the station "Luna-11" was conducted on the 1st of October at 05 hrs 03 min. thereafter due to total exhaustion of power-supply on board the communication with the station ceased.

The processing and analysis of obtained information continue. The results of investigations, carried out by the Soviet automatic station "Luna-11", will be published in the press.

"Pravda", 5th October 1966.

TASS COMMUNIQUE IN SPACE "LUNA-12":

In accordance with the program of further investigation of the moon and lunar space a moon shot was accomplished in the Soviet Union on the 22nd of October 1966 at 11 hrs 42 min Moscow time.

The rocket carries ~~automatic~~ station "Luna-12".

The main object of the station is the further perfecting of the lunar satellite systems and scientific investigations in the lunar space.

Primary results of the measurements processing indicate, that the trajectory of the station is close to prescribed. At 16 hrs Moscow time on the 22nd of October 1966 the station "Luna-12" was 45 thous. km from the earth above a point on terrestrial surface with coordinates 20°30' N and 107°42' E. Two sessions of radio-communication was conducted with the station. According to telemetric data, the devices aboard the station function normally.

A special measuring center on the ground is following the flight of the station. The coordination center is processing the incoming information.

"Pravda", 23rd October 1966.

TASS COMMUNIQUE "LUNA-12" - IN ORBIT:

As communicated previously, on the 22nd of October 1966 automatic station "Luna-12" was placed into lunar trajectory. In accordance with the program trajectory correction was carried out on the 23rd of October at 22 hrs 12 min Moscow time.

On approach to the moon on the 25th of October 1966 at 23 hrs 47 min Moscow time the station was decelerated.

As a result of successfully carried out maneuver the automatic station "Luna-12" entered into selenocentric orbit close to prescribed and became the third Soviet lunar satellite.

According to telemetric data, the systems aboard and scientific instruments for lunar space investigations are functioning normally. Radio-communication with the station "Luna-12" is steady.

The coordination center is processing the incoming information.

"Pravda" 27th October 1966.

"LUNA-12" TRANSMITS:

On the 22nd of October 1966 launching was accomplished in the Soviet Union of automatic station "Luna-12". On the 25th of October at

23 hrs 47 min Moscow time the automatic station "Luna-12" was placed into selenocentric orbit and became the third Soviet lunar satellite.

The program for the study of the moon and lunar space envisages various scientific investigations, which would permit to study in detail the celestial body nearest to our planet.

The scientists are interested to obtain as accurate as possible information on the various lunar areas. It is important for them to know the size, number and shape of the craters, nature of the local relief. This requires pictures of lunar surface with sufficiently high degree of resolution. The ground telescopes do not make it possible to distinguish fine details of relief on the moon. From the earth even at optimum atmospheric conditions it is impossible to photograph on the moon details less than 400-500 meters in dimension.

The best way for observation of finer details, measurable in meters, are the lunar satellites, placed into a comparatively low orbit and equipped with photo-camera, and also with a special system for transmitting the shots to the earth.

For a successful resolution of this problem it was necessary to perfect the system for the guiding of the station into the lunar orbit, perfecting orientation and stabilization equipment and to carry out a number of other composite experiments.

Investigation program of the moon and lunar space requires resolution of many scientific and engineering problems. The implementation of this program was begun by the Soviet scientists and designers in 1959, when the first three Soviet luniks initiated regular study of the moon from a close distance.

During almost four centuries of telescopic observations the visible side of the moon was well investigated. Hundreds of thousands of its details were mapped. Surface temperature has been measured, reflection factors found of electromagnetic waves, mass ratio determined of the earth and the moon, etc. However, the other side of the moon, just as before remained mystery for the people.

For the first time in the history of the earth civilization Soviet automatic station "Luna-3" in October 1959 transmitted picture of the other side of the moon. The shots made by the station covered about two thirds of the lunar surface, previously unapproachabl for observations. During the six years no one was able to repeat this grandiose experiment.

In July of 1965 another Soviet automatic station - "Zond-3", passing at a distance of about ten thousand km from the lunar surface photographed part of the invisible hemisphere of our satellite, remaining outside the vision field of the station "Luna-3". The shots, transmitted by the stations "Luna-3" and "Zond-3", have practically completed photographic survey of the whole surface of our eternal satellite. The photographs, which are now at the disposal of the scientists , show over 95% of the lunar surface. Discovered on the other side were vast depressions, named thalassoids, crater chains of enormous extent and a great number of craters. Approximately 170 objects on the other side of the moon were named by the Commission of the Academy of Sciences USSR after outstanding scientists, who worked in different spheres of the science.

But the flight program of these vehicles did not envisage obtaining of photographs with high resolution of details on the lunar surface, as the shooting was from a great altitude.

On the 3rd of February 1966 the station "Luna-9" for the first time in history accomplished soft landing on the moon. The series of shots, obtained by this station, were made with very high resolution. On some shots it is possible to distinguish surface details about 1-2 mm in size. But this information pertained only to the area in the vicinity of touchdown point.

On the 3rd of April 1966 automatic station "Luna-10" became the first in the world lunar satellite. Following it on the 28th of August automatic station "Luna-11" was placed into selenocentric orbit. The program of scientific investigations, implemented by these stations contributed a lot of new facts to our knowledge of the moon and the lunar space.

And now there is a new achievement - the third Soviet lunar satellite - station "Luna-12". One of the objects of this station was to obtain and transmit to the earth shots of individual areas of lunar surface, made from comparatively close distance.

The automatic station "Luna-12" is a composite space vehicle. The main power unit of the station is the correctingbrake rocket engine, on which in hermetic containers are the blocks of orientation system radio-set, photo-TV cameras, control system and power-supply accessories. In the upper section of the station is the instrument compartment, partially closed by the radiator of the thermal control system. Fitted on the body of the station are the receiving and transmitting antennas, part of the scientific instruments not requiring hermetization reserve-gas cylinders for micro-rockets of orientation system and the micro-rockets themselves, fitted on special brackets.

The propulsion system of the station, consisting of jet motor with pumping fuel delivery, control members and fuel tanks, is meant for trajectory correction, bracking of the station close to the moon and position stabilization during the engine operation.

The orientation and control systems implement orientation of the station in space and its subsequent stabilization prior to correction and deceleration, turn of the station for obtaining the required decelerative force, engine cut-off after correction and deceleration, orientation and stabilization of the station during the shooting of the lunar surface cut-in and cut-off of photo-television camera, etc. The compartments of control and orientation systems contain a set of various gyroscopic and controlling devices, electronic-optical and programing timers.

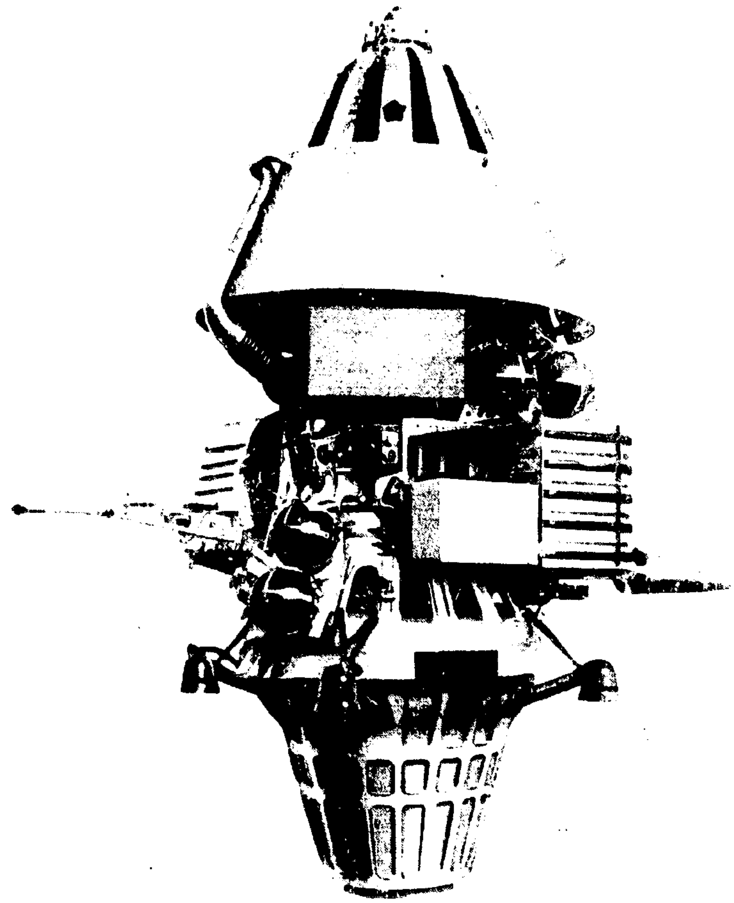

Fig: 20 - Automatic station "Luna-12".

1 - cylinders with gas for operating elements of orientation system; 2 - photo-TV camera; 3 - radiator of thermal control system; 4 - radiometer; 5 - instrument compartment; 6 - chemical battery; 7 - optico-mechanical block of orientation system; - antenna; 9 - electronic block of orientation system; 10 - control rockets; 11 - braking rocket.

The radio-set provides control of the station both from the earth and independently, information transmission on the performance of the station's systems and scientific instruments, trajectory measurements.

For the shooting of lunar surface and transmission of pictures to earth, a special TV camera is set up on the station.

In accordance with the program the photo-TV camera took pictures of the lunar surface and automatically processed the film. The pictures were initially transmitted to the center of distant space radio-communication in inspection, conditions. Thereafter the most interesting shots were picked out and transmitted from aboard in normal conditions.

The complex of devices and systems in the station "Luna-12" gives out a lot of heat. Moreover, the station gets additional heat due to solar irradiation. Therefore to maintain normal thermal conditions of operation of all the devices and instruments of the station it has a special thermal control system of passive-active type.

Applied as passive means of thermal control are the appropriate coloring of external surfaces, heat-insulation and special screens. The permits to maintain normal temperature conditions in all compartments of the station, except the instrument compartments of the control system, where the preset temperature conditions in every flight branch is assured by the active thermal control system. Fitted on the body of station "Luna-12" are the State emblem of the

Union of Soviet Socialist Republics and the banner of the Soviet Union.

In accordance with the flight program the station "Luna-12" entered selenocentric orbit close to equatorial. The calculated point of guiding in this case was at a distance of 1290 km from the lunar surface. At a moment of reaching this point the velocity of "Luna-12" was 2085 m/sec. At this velocity the lunar gravity is incapable of changing the flight path of the station enough to transfer it into the lunar satellite orbit. Therefore, there had to be deceleration to transfer the station into selenocentric orbit.

To accomplish deceleration an hour before reaching the prescribed point of trajectory, when the station was at about 8000 km from the lunar surface, it was oriented in exactly determined position in relation to the moon - on lunar vertical. Then the station was turned at a certain angle from this direction and on reaching the prescribed point the propulsion system was cut-in and operated for the prescribed 28 sec. As a result the velocity of the station was reduced to 1148 m/sec and the automatic station "Luna-12" transferred from the flight path to lunar satellite orbit of the following parameters:

- maximum distance from lunar surface (at apocythion) - about 1740 km;
- minimum distance from lunar surface (at pericythion) - about 100 km;
- orbital period - 3 hrs 25 min.

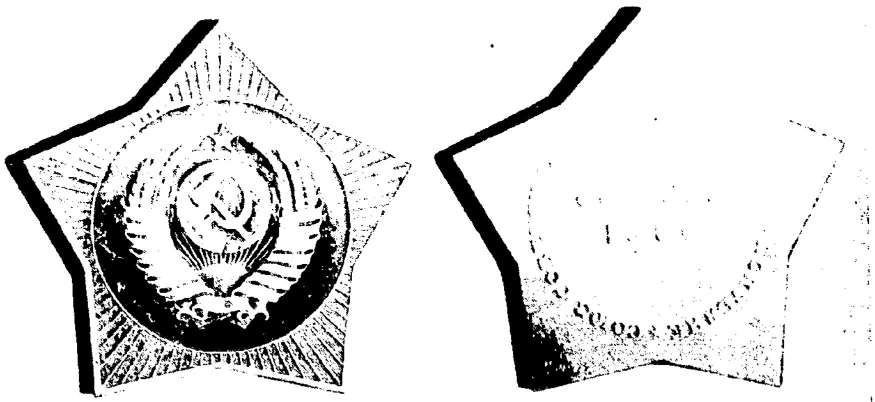

Fig: 21 - State symbol with the emblem of the Union of Soviet Socialist Republics, fitted aboard the automatic station "Luna-12", and its reverse side.

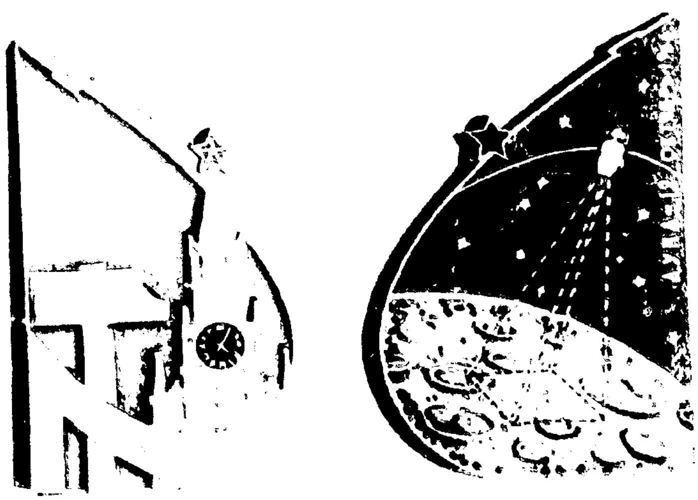

Fig: 22 - Pennant of the Soviet Union, set up aboard the automatic station "Luna-12" and its reverse side.

All the operations for this maneuver were implemented automatically.

After the station entered into lunar satellite orbit it was in an oriented position. In orbiting the automatic station appeared above the illuminated part of the moon and at this moment the TV camera was cut-in.

Mention should be made of the high operating precision of the systems and operating units, which orient the station in the area of photographing. Maximum deviation of the station from the prescribed direction was not above a few angular seconds. Altitude of picture-taking and coordinates of the photographing section were actually not different from the prescribed.

At the end of photographing the station began transmission of pictures to the earth through television channel. In this case each shot was divided in the TV picture into 1100 lines (in ordinary television there are only 625 lines). This produced good quality of pictures.

After transmission of pictures the TV set was cut-off.

The automatic station "Luna-12" continues investigations begun by luniks "Luna-10" and "Luna-11". The characteristics are being studied of the lunar gravity field from the orbital evolution of the station. Further investigation is being conducted of the radiation conditions in the lunar space and distribution of micro-meteorites on the moon. "Luna-12" continues radio-astronomic investigations, begun by "Luna-11" in unapproachable from the earth bands of long and medium radio-waves.

The launching of the automatic station "Luna-12" is a new success of the Soviet science and technique.

"Pravda", 6th November 1966. (TASS)

TASS COMMUNIQUE THREE-MONTH PROGRAM OF INVESTIGATIONS BY AUTOMATIC STATION "LUNA-12" IS COMPLETED:

As has already been communicated, on the 22nd of October 1966 automatic station "Luna-12" was launched in the Soviet Union. On the 25th of October the station was inserted into the lunar satellite orbit.

During the past period the station "Luna-12" flew in lunar space 9 million 800 thousand km, and 302 sessions of radio-communication were conducted with the station.

On the 19th of January 1967 the long-flight program of the third Soviet lunar satellite - automatic station "Luna-12" - was successfully completed, and at the 602-nd revolution the radio-communication with the station have ceased.

During the three-month flight the station carried out a scientific investigations and transmitted to the earth unique pictures of the lunar surface, obtained from the lunar satellite orbit. In accordance with investigations program detailed measurements were carried out of gamma-radiation on lunar surface, X-ray fluorescent radiation, corpuscular in long wavelength range, begun by the station "Luna-11" were continued.

The result of scientific investigations, carried out by the station "Luna-12", confirm and expand the earlier obtained information about the moon and lunar space.

"Pravda", 22nd January 1967.

TASS COMMUNIQUE ON THE LAUNCHING OF "LUNA-13":

In accordance with the program of space investigations a moon shot was accomplished in the Soviet Union on the 21st of December 1966 at 13 hrs 17 min Moscow time.

The rocket carried automatic station "Luna-13".

The main object of the station is further investigation of the moon and circumlunar space.

The primary processing results of measurements show, that the station's trajectory is close to prescribed.

At 17 hrs Moscow time on the 21st of December 1966 the station "Luna-13" was at 44 thous. km from the earth above a point of terrestrial surface with coordinates 44°31' N and 80°11' E.

Two sessions of radio-communication were conducted with the station. According to telemetric data the instruments aboard the station operate normally.

Flight observations of the station are being conducted by a special ground center. The coordination center is carrying out processing of the incoming data.

"Pravda", 22nd December 1966.

THE PROGRAM IS SUCCESSFULLY COMPLETED:

The program of the moon investigation by means of automatic station "Luna-13", which soft-landed on the moon on the 24th of December 1966, is completed in full.

As a result of carried out investigations unique data were obtained on the physico-mechanical properties of surface lunar layer, of high scientific value. TV pictures were transmitted of lunar surface panorama in the touchdown area of the station at different heights of the Sun.

Scientific information, received from the automatic station "Luna-13" is being processed.

"Pravda", 31st December 1966. (TASS)

"LUNA-13" NARRATES:

On the 24th of December 1966 at 21 hrs. 01 min Moscow time the Soviet automatic station "Luna-13" soft-landed on the lunar surface. This is the second Soviet station to have made a soft lunar landing in this year: the first, as we know, was the Soviet station "Luna-9".

Between the flights of these two stations three Soviet lunar satellites - automatic stations "Luna-10", "Luna-11" and "Luna-12" - carried out a set of scientific investigations, and one of them, in accordance with the program transmitted a series of lunar surface pictures, obtained from altitudes from 100 to 340 km.

However, the lunar satellites do not make it possible to carry out direct investigations of many important physical and microstructural characteristics of the lunar cover.

For the resolution of these problems the devices and scientific instruments have to be delivered onto lunar surface.

The problem of direct investigation of mechanical and physical properties of the lunar ground has for many years attracted the attention of astronomists and astrophysicists. The lunar surface for milliards of years was in conditions of vacuum, under the effect of a flux of cosmic rays, meteorites, X-ray and ultraviolet rays coming from the Sun, in conditions of sudden changes of temperature - from 100-150° cold of lunar night to +100-150° during the lunar day. Previously the science had no information on the physical and mechanical characteristics of substances, existing in such unusual from terrestrial viewpoint conditions. Just a few years previously extremely contradictory hypotheses were expressed by various investigators regarding the assumed types of lunar matter: lava cover, slag-type surface, thick dust or ash cover, open lattice mineral structures - dendrites and other types of surface.

Of great interest to science are the direct measurements, showing the nature of lunar surface, since in the earth laboratories it is impossible to reproduce the composite processes of many ages, which determine its properties.

Side by side with these investigations it was necessary to continue other scientific investigations, begun earlier.

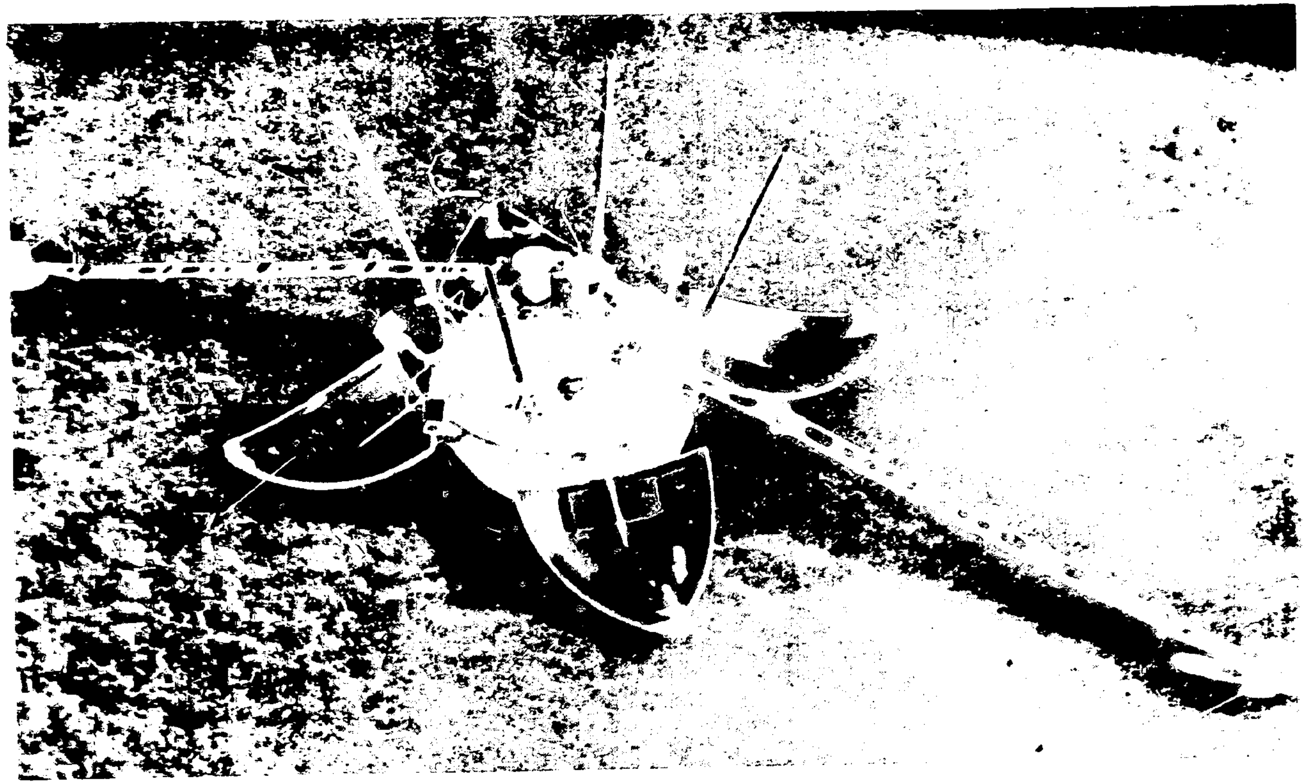

Fig. - 23 - Automatic station "Luna-13".

1 - lobed antennas; 2 - rod antennas; 3 - mechanism for taking out instruments; 4 - mechanical soil-density meter; 5 - radiation density meter; [illegible] - TV camera.

In construction the automatic station "Luna-13" has some differences from its predecessor - station "Luna-9". Experience, obtained from the first station, which soft-landed on the moon, made it possible to improve the construction of "Luna-13", and the resolution of a number of scientific prob ems necessitated equipment of the station with new scientific devices.

Inside the air-tight body of the "Luna-13"is a frame with receiving and transmitting radio-set, electronic programing timers, chemical batteries, automatic devices, scientific and telemetric instruments, and also the thermal control system.

On the outside of the "Luna-13" body (Fig: 23) are mounted 4 lobed and 4 rod antennas, TV arrangement and two mechanisms for taking out devices. Prior to bringing the automatic lunar station (ALS) into working position the lobed and rod antennas, as well as the mechanisms for taking out were in folded condition and held in this position by a special lock. On command from the programing timer on board the ALS was brought into working position; with the opening of lock the antennas and bringing out mechanism unfolded. At the end of one of the mechanisms is a mechanical soil-density meter, on the other - radiation density meter. The carry-out mechanisms made it possible to set up the soil-density and radiation density meter on the lunar surface within 1.5 m from the ALS.

The TV arrangement of "Luna-13" - optico-mechanical scanner, resembles in construction TV or photo-telegraphic set. It should be mentioned, that optico-mechanical system meets the rigid demands of weight, overall size, energy consumption and reliable work, which are demanded of the ALS devices.

The time of the full round scanning of the TV camera is about 100 min and the depth of clearly-defined space from 1.5 m to infinity permitted to distinguish details 1.5-2 mm in size at a distance of 1.5 m.

The TV camera has automatic adjustment of the amplification factor of signal in relation to illuminance of the lunar surface. The axis of the TV camera on sufficiently level horizontal surface was inclined at approximately 16° to local vertical. This made the conditions very suitable for transmission of micro-relief pictures.

To ensure the required temperature conditions the use on "Luna-13" is of active type thermal control system with a special external thermal insulation. The active thermal control system was cut-in immediately the station landed on the moon. Under the pressure inside the ALS water from the soft tank was fed into evaporator-valve, which is at the same time heat-exchanger. With evaporation of water the evaporator-valve absorbed the heat, given out by devices during operation. The adjustment of evaporator-valve enabled to maintain the temperature of the station with 19-30°C.

The carrier-rocket, which took-off on the 21st of December 1966 at 13 hrs 17 min Moscow time, inserted automatic station "Luna-13" and the rocket cluster into intermediate orbit of the earth satellite. At exactly prescribed time the rocket cluster imparted to the station velocity, required for the lunar trajectory. According to data, computed by the coordination center, trajectory correction was implemented on the 22nd of December, as a result of which the new flight path was headed practically at the calculated point of lunar landing.

On approaching the moon, 2 hours before the landing, preparation begun for the station's deceleration. The station was oriented in space, stabilized, and at 20 hrs 59 min the brake rocket was cut-in, at 21 hrs 01 min Moscow time on the 24th of December 1966 the "Luna-13" made a soft landing on the moon in the area of Oceanus Procellanum (Fig: 24).

Approximately 4 minutes after landing on command of the programing timer on board the station was placed into working position and the first session begun of radio-communication with the station. Telemetric data have shown, that all the systems of the station were working normally, temperature and pressure on board were within the preset limits.

The station "Luna-13" soft-landed in area about 400 km from the touchdown point of ALS "Luna-9". It is essential to mention the morphological difference in the areas of landing of both the stations.

The "Luna-9" landed in direct vicinity to the eastern margin of the continental shield, extending to the whole reverse hemisphere, whereas the touchdown point of the AMS "Luna-13" is within an extensive plain of "marine" type.

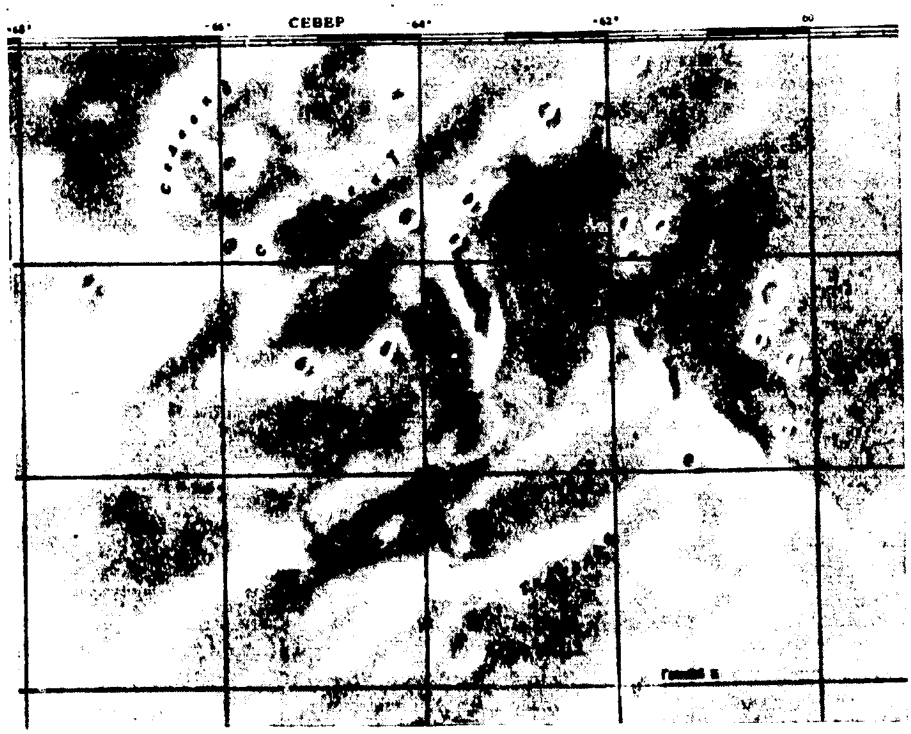

Fig. 24 - Soft-landing area of the Soviet Automatic Station "Luna-13".

The touchdown point of selenographic coordinates 18°52' N and 62°03' W is marked by a cross. The grid size is 60 x 60 km.

The nearest to the touchdown point lunar formations are the craters Seleucus (43 km in dia.) and Schiaparelli (24 km in dia,). Around the touchdown point, within an area of 100 km radius there are no formations, the size of which is over 3.5 km. Moreover, the absence should be emphasized of sufficiently large formations, rising above the surrounding locality. On the given photograph (Fig: 25) this last fact specifies calm nature of the line of horizon.

The most interesting feature of the landing area, known from terrestrial observations is the abundance of so called joints (depressions of considerable extent, tens of km in length). These are arranged in diverging beam with strike from south-west to north-east. The large number of light spots, marked in this area, indicates presence of local accumulations of various type of depressions.

"Luna-13" has landed before the sun rose above this place. The sun-rise on the 25th of December was at 3 hrs 30 min Moscow time. Since the landing area is close to equator, the sun was rising there almost perpendicularly to the line of horizon, moreover its height increased by 0.5 degrees every hour. Prior to the passage of the sun through the zenith, i.e., before the local lunar noon, shadows from the objects, east to west (in the afternoon - west to east), almost did not vary their direction. Therefore it is simple to orient the panoramic fragments by compass. The published photograph (Fig: 25) shows lunar landscape south-ward from the station. It was received during the third transmission of pictures. At the transmission moment of the first pictures of the surrounding locality the height of the sun was 6 degrees. During the second transmission it was 19 degrees and, finally, the published panoramic fragment was obtained with the height of the sun above the horizon of 32 degrees. The visibility of the lunar landscape details depends to a great extent on conditions of illuminance. This peculiarity of reflecting capacity of the lunar surface is known since long by observations from the earth. The highest amount of light is dispersed by the lunar surface toward the sun. And the lower is the sun, the more sharply this property is defined. It is the brightness of the landscape that increases, if the observation is from the side of the sun. As a result panorama, transmitted during the second session, shows a light halo around the shadow of the station.

The primary analysis of received pictures shows, that the ground structure at the touchdown place of "Luna-13" has a lot in common with the ground structure in landing areas of "Luna-9" and American station "Surveyor-1", which soft-landed in the summer of this year in the area of Flamsteed crater. In close examination the surface is highly pitted, with individual grains from several cm and over. The study of formations arrangement confirms the conclusions, that the stones have fallen on the surface at low speed. Their source could only be a volcanic eruption, or formation of primary crater as a result of meteorite impact. Moreover the fall trajectory was rather steep, as otherwise (with flat trajectory) traces would have remained on the surface toward the source of stone ejection. Therefore, the mineralogical composition of the stones is similar to the soil composition. They are, undoubtedly, not meteorites: impact velocity of meteorites with lunar surface cannot be less than 2.4 km/sec, which invariably results in explosion with formation of a crater-like hollow in the surface.

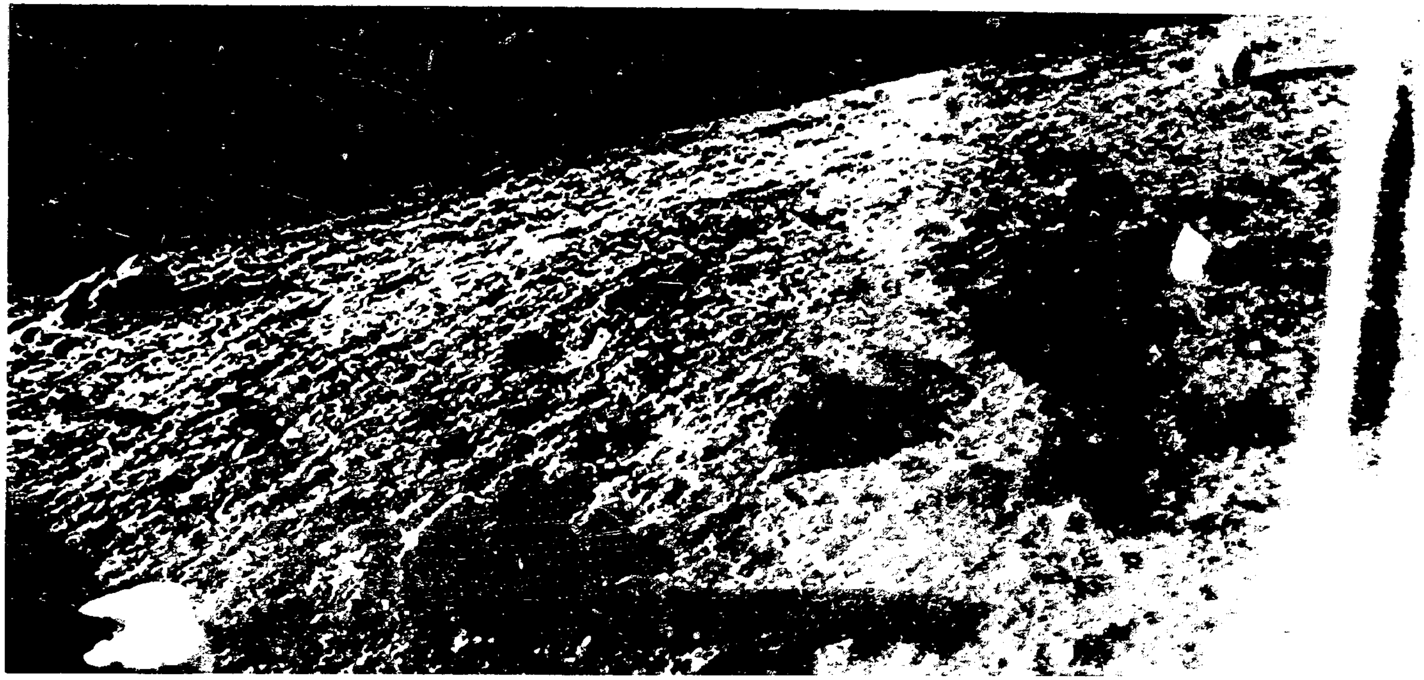

Fig: 25 - Fragment of the lunar landscape panorama, transmitted by the Soviet Automatic Station 'Luna-13'.

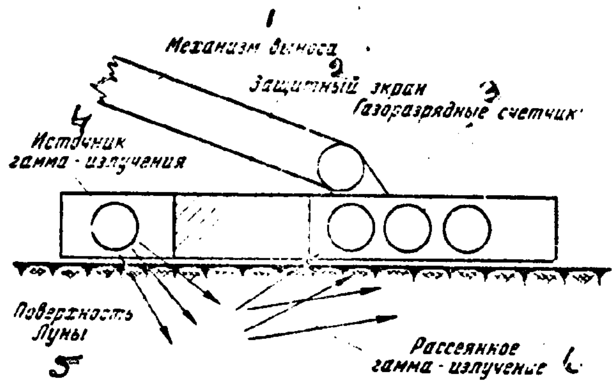

Fig: 26 - Radiation density meter.

1 - carry out mechanism; 2 - protective screen;

3 - gas-discharge counter; 4- source of gamma-radiation;

5 - lunar surface; 6 - dispersed gamma-radiation.

The published picture clearly shows a group of stones (top left corner), formed, apparently, with the fall of a monolith fragment. The bottom left of the picture shows a long shadow from a stone of a very remarkable, flat shape, as though protruding from the ground. Moreover, the photographs show details of the station, thrown off during landing.

To carry out scientific investigations program the automatic station "Luna-13" carried the following devices:

- soil-density meter, enabling to determine properties of the outermost layer of lunar matter (within a few cm);

- dynamograph, recording duration and magnitude of dynamic overloading force, emerging with the landing of ALS on lunar surface;

- radiation density meter, enabling to determine specific gravity (density of lunar matter).

Joint measurements by means of these devices made it possible to obtain an all-round information regarding physico-mechanical properties of the lunar surface at the touchdown point.

The station also carries a device for recording cosmic rays, meant to continue investigations of radiation environment on lunar surface, begun by means of the station "Luna-9".

The soil-density meter had a conical tip of titanium. The tip is connected with power rocket engine, developing within one second a force of 7 kg, under the effect of which the stamp of the meter is implanted into the ground surface.

The dynamograph consisted of piezoelectric [illegible] of overload and electronic circuit, memorizing duration and magnitude of acceleration force, obtainable during landing.

From these parameters the mechanical properties were estimated of the lunar surface in the zone of landing, as the hard surface corresponds to short impulse of overload with high amplitude, and the soft - to a more prolonged, but correspondingly of lower amplitude.

The preliminary comparison of the obtained acceleration impulse with results of model experiments, carried out in terrestrial conditions, gives grounds to assume, that the mechanical properties of the surface lunar layer upto 20-30 cm are similar to properties of earth soil of average density.

Besides the mechanical properties measurements of lunar matter the data are also of interest of its density volume weight. It is well known, that the average volume weight of lunar matter (for the moon as a whole), determined from astronomical observations data, is lower, than the average volume weight of the earth matter (3.34 g/cu. cm as against the 5.51 g/cu.cm for the earth). The density of the external lunar layer was upto now investigated only by astronomic methods: the first direct measurements of volume weight of surface layer were made by means of the station "Luna-13".

The radiation density meter of lunar matter (Fig: 26) contains:

- small radio-active source of gamma-radiation;
- three blocks of gas-discharging counters of gamma-quanta;
- screen, protecting gas-discharging counters from direct falling of gamma-rays from the source.

In contact of density meter with the lunar surface the latter is irradiated by gamma-quanta, coming from the source, and disperses them in all directions. A certain portion of dispersed quanta falls onto the gas-discharging counters of devices, which measure intensity of dispersed flux. It is a known fact, that the flux intensity of dispersed gamma-quanta is proportional to density (specific gravity) of lunar matter. According to preliminary data, the flux intensity of dispersed by lunar surface gamma-quanta corresponds to density, not over one gram per cubic centimeter, i.e., to considerably lower density, than that of the earth soil and average density of the moon. The measured value is close to the density of porous or granular, weakly-cemented rocks.

The device, set up on "Luna-13", for recording of cosmic corpuscular radiation consisted of gas-discharging counters, cut-in for coincidence. This device in contrast to those on the station "Luna-9" did not record gamma-radiation, but only the charged corpuscles contained in the cosmic radiation and enabled to determine the reflective capacity (albedo) of lunar surface for cosmic rays. It was found, that the lunar surface "reflects" about 25% of particles, falling on it from the outer space. This is due to the fact, that the composition of cosmic radiation contains particles of high energy. With the passage of these particles through the lunar matter there is formation of secondary particles, obtaining partial energy of the primary particles. Some of the secondary particles move in directions, composing a noticeable angle with direction of the primary particles. Thus, under the effect of cosmic rays the moon looks as though it "gleams", radiating particles of high energy. However, the measurements have shown, that the total intensity of high energy particles on the moon in calm state of the sun is not high.

The same device of "Luna-13" confirms the conclusion about the low radio-activity of the lunar surface, obtained by a similar device on "Luna-9".

Now there are no more doubts, that it is precisely the space vehicles will provide information, which will permit to resolve anew such important problems of science, as the origin of the Solar System, generation and development of life on other planets and internal structure of celestial bodies. In this respect the attention, which is being paid to the moon, is explained not only by the fact, that it is the nearest to us celestial body and, hence, the most convenient for various experiments, but also by the fact, that according to a whole series of characteristics the satellite of our earth is typical for a group of bodies in the Solar System.

Thus, the new investigations of the moon is an important step on the way to resolving further mysteries of space.

"Pravda", 31st December 1966.

CHAPTER-IV

SPACESHIPS - SATELLITES

TASS COMMUNIQUE ON THE LAUNCHING OF THE FIRST SOVIET SPACESHIP-SATELLITE

During the last few years scientific investigations and experimental construction are being conducted in the Soviet Union on preparing a manned flight into space.

The achievements of the Soviet Union in constructing Earth satellites of high weight and dimensions, successful testing of a powerful carrier-rocket, capable of placing into prescribed orbit a satellite weighing several tons, made it possible to begin construction and testing of a spaceship for a prolonged man-in-space flight.

On the 15 of May 1960 a spaceship was launched in the Soviet Union into Earth satellite orbit. According to received data, the spaceship satellite in accordance with calculations was placed into almost circular orbit, at altitude of about 320 km from the Earth surface, thereafter it separated from the carrier-rocket. The initial orbital period of the spaceship is 91 minute. Orbital inclination is 65°. The weight of spaceship without the last stage of carrier-rock is 4 tons 540 kilogram. The spaceship has a hermetic cabin with a load equal to that of a man, and with all the equipment required for the future man-in-space flight, moreover, various apparatus, weight of which with power sources is 1477 kg.

The launching is designed for improving and checking of the spaceship systems, which assure safe flight and flight control, return to Earth and necessary conditions for a man in space flight. This takeoff initiated the composite work on construction of reliable spaceships, assuring a safe flight of man in the space.

On receiving of necessary data from the spaceship the hermetic cabin weighing 2.5 tons will be separated from it. In the present launching the return to Earth of hermetic cabin is not envisaged, and the cabin after checking reliability of its functioning and separation from the spaceship, just as the spaceship itself, will begin descent on command from the Earth and will cease existing with entry into dense atmospheric layers.

The spaceship-satellite carries radio-transmitter "Signal", operating on frequency 19.995 megacycles per second both in telegraphic and telephonic conditions of transmission.

Besides the transmitter "Signal", the spaceship-satellite carries special radio-sets for transmission of data to Earth on performance of the set up devices and for the exact measurements of orbital elements. The scientific and measuring instruments of satellite are energized from the chemical current sources and solar batteries.

Processing of the primary data, received from spaceship-satellite has shown, that the installed apparatus operates normally. The ground centers follow regularly the spaceship-satellite.

At 6 hours 11 minutes the spaceship-satellite passed above Moscow.

At 7 hours 38 minutes Moscow time the Soviet spaceship-satellite passed above Paris. Above Leningrad the spaceship-satellite passed at 7 hours 43 minutes. At 10 hours 36 minutes Moscow time the spaceship-satellite flew above New York.

Visually the spaceship-satellite could be observed in the area of Vladivostok on 15 of May at 21 hours 12 minutes in south-eastern direction.

"Pravda", 16 May 1960.

INVESTIGATION PROGRAM SUCCESSFULLY COMPLETED. TASS COMMUNIQUE ON THE ORBITING OF SPACESHIP-SATELLITE

The investigation program, planned for the flight of spaceship-satellite has been completed on the 19 of May 1960.

In accordance with the program to implement the descent of the spaceship-satellite from the orbit a command was transmitted on the 19 of May at 2 hrs 52 min for switching on the braking rocket and separation of hermetic cabin.

The braking rocket operated and stabilization of the spaceship was attained during the operation of propulsion system. However, due to deffect, which appeared at this time in one of the units of the spaceship orientation system the direction of decelerating force deviated from the calculated one. As a result instead of velocity decrements there was some increment and the spaceship moved into a new elliptical orbit, lying almost in the previous plane, but with considerably greater apogee.

The separation of hermetic cabin took place and in this case normal operation of the cabin's stabilization system was recorded.

As a result of the first launching of the spaceship-satellite a number of most important scientific and technical problems has been resolved.

The checking of a reliable takeoff and flight was made according to prescribed program of the powerful carrier-rocket, assuring high accuracy entering of the spaceship into an almost circular orbit.

During the flight there was a reliable control of the spaceship-satellite and its orientation for several days.

The obtained data of telemetric measurements show, that during the whole flight the conditioning and thermal regulation systems operated normally and provided conditions, required for the future man-in-space flights.

Communication with spaceship-satellite in telegraphic conditions took place normally. In telephonic communication with retranslation through apparatus of the spaceship of ground radio-station transmission there was a lot of noise with high distortions.

Special radio-centers, set up for transmitting commands to the spaceship, orbital control of its flight and transmission from aboard of telemetric information, have successfully carried out their task.

Functioning of self-orienting solar batteries was normal.

All the basic equipment for descent is correctly designed and can assure the implementation of this problem.

Data on the first flight of spaceship-satellite provided a lot of material for accomplishment of the future controlled flight of a man-in-space and have shown the correctness of the main positions, adopted in construction of the spaceship. Results of this work permit to carry on further tests.

At present the spaceship-satellite and the near-by hermetic cabin are orbiting with a period of 94.25 munutes. The perigee is 307 km, and the apogee - 690 km. The orbital inclination is 65°.

The last stage of the carrier rocket is continuing its previous orbiting.

Radio-transmitter "Signal" on the spaceship-satellite continues to function normally, transmitting to the Earth information regarding operation of systems and devices.

TASS COMMUNIQUE ON THE LAUNCHING OF THE SECOND SOVIET SPACESHIP-SATELLITE.

In accordance with plans for the study of the outer space a second spaceship was launched in the Soviet Union on the 19th day of

August 1960 and entered orbit of the earth satellite. The main object of the launching is the further improvement of the systems, providing for the vital activity of a man, and also safety of his flight and return to Earth.

In the cabin, equipped with everything necessary for the future flight of a man, are the test animals, including two dogs, named "Strelka and "Belka".

During the flight of the spaceship-satellite it is envisaged to carry out a number of medico-biological experiments and of scientific investigations program of the outer space.

The second Soviet spaceship-satellite is placed into an almost circular orbit, with altitude about 320 km.

The initial orbiting period of the spaceship is 90.6 min, orbital inclination 65°. The weight of the spaceship-satellite without the last stage of carrier-rocket is 4600 kg.

The spaceship-satellite carries transmitter "Signal", operating on frequency 19.995 mega-cycles per second, telemetering equipment for transmission to Earth of data on test animals and performance of all the systems aboard the satellite.

To observe the behavior of test animals television equipment is set up aboard the spaceship-satellite.

Preliminary data have shown, that the systems aboard the spaceship operate normally.

"Pravda", 20 August 1960.

TASS COMMUNIQUE OUTSTANDING SUCCESS OF SOVIET SCIENCE AND TECHNIQUE

FOR THE FIRST TIME IN HISTORY THE LIVING BEINGS SAFELY RETURNED FROM SPACE TO EARTH

On completion of investigations program, estimated for 24 hrs, and obtaining of data on vital activity of the animals and normal functioning of the system aboard the spaceship, a command was given for its descent from the orbit. The command was given on the 18th revolution. The control system of the spaceship and braking rocket operated with high precision and brought down the spaceship in prescribed area. Deviation of the touchdown place from the calculated one was about 10 km.

The spaceship-satellite weighing 4600 kg (neglecting the weight of the last stage of the carrier-rocket), having a special thermal protection, passed successfully through the Earth's atmosphere. The spaceship-satellite and the separated capsule with the test animals have landed successfully.

Planes and helicopters brought to the touchdown point medical and technical personnel.

All the test animals, including the dogs Strelka and Belka feels very well after the flight and landing.

At present an all-round examination is being conducted of the animals returning from the space flight. The equipment, which was developed, assured normal vital activity of the animals in flight.

Thus, for the first time in history the living beings, having completed flight in space with extent of over seven hundred thousands km, have safely returned to Earth.

The launching and return to Earth of the spaceship-satellite, created by the genius of Soviet scientists, engineers, technicians and laborers, is a forerunner of the man's flight into interplanetary space.

"Pravda", 21 August 1960.

TO SCIENTISTS, ENGINEERS, TECHNICIANS, WORKERS, THE WHOLE STAFF PARTICIPATING IN CONSTRUCTION, LAUNCHING AND RETURN TO EARTH OF SPACESHIP-SATELLITE WITH LIVING BEINGS:

The Central Committee of the Communist Party of the Soviet Union and the Council of Ministers USSR warmly congratulate scientists, designers, engineers, technicians, workers, the whole staff, who constructed the powerful spaceship and accomplished for the first time in history the flight and successful return to the Earth of this spaceship with living beings.

To accomplish a successful flight of the huge spaceship weighing 4600 kg with living beings and its return to Earth required resolution of the most difficult scientific and technical problems to assure:

- controlled flight of the spaceship and its landing on Earth with high precision at prescribed point;
- conditions for normal vital activity of living beings in space;

— reliable radio and television communication with the space ship.

This outstanding achievement is a remarkable scientific achievement of Soviet people, triumph of our national science, technique and industry, a great contribution into the treasury of the world science and culture, opening a new era in the mastering of the outer space. Now there is a practical possibility for a manned-space flight.

Dear comrades! You have demonstrated by your glorius deeds once again to the whole world the might of the scientific and technical achievements of the country of socialism, indisputable advantages of the socialists regime, creative genius of the great Soviet people. We wholeheartedly wish you new outstanding successes.

Glory to Soviet scientists, designers, engineers, technicians and workers, glorifying by their labor our great socialists Motherland, progressing under the wise leadership of Lenin's Communist Party to new victories in the building of communism!

Central Committee
CPSU

Council of Ministers
USSR

"Pravda", 23 August 1960.

SECOND SOVIET SPACESHIP:

On the 19 of August 1960 a successful launching was accomplished in the Soviet Union of a second spaceship into Earth satellite orbit.

Weight of the spaceship without the last stage of the carrier-rocket is 4600 kg.

The main object of the launching of the second spaceship-satellite is further improvement of the systems assuring vital activity of a man, and also safety of the flight and return to Earth. It was envisaged to carry out during the flight a series of medico-biological experiments and implementation of scientific investigations program in the outer space. For a successful flight of the second spaceship-satellite with living beings on board and return to Earth required resolution of the most composite scientific and technical problems for assuring:

— controlled flight of the spaceship and return to Earth at a prescribed point;

— conditions of normal vital activity of live beings in space flight;

— reliable radio and television communication with spaceship.

All these problems were successfully resolved. The huge spaceship with its passangers - the dogs Belka and Strelka and other living beings - has safely returned to Earth. This historic event brought nearer the time of direct conquering by man of the circumsolar space. Faultless performance of all the systems for insertion of spaceship into orbit, as well as the constructive specifications of the powerful carrier-rocket enabled to obtain an orbit, practically not different from the calculated one.

The second Soviet spaceship-satellite was placed into an almost circular orbit with apogee 339 km and perigee 306 km. The initial orbital period of the spaceship was 90.7 min., orbital inclination - $64^{\circ}57'$.

CONSTRUCTION OF THE SPACESHIP-SATELLITE:

The spaceship-satellite consisted of two main sections - the cabin and instrument compartment. The following items were placed in the cabin:

— devices for the vital activity of animals in flight;

— equipment for biological experiments;

— a part of the scientific investigations devices (photo-emulsion blocks and radiometer);

— a part of the orientation system;

— apparatus for recording behavior of cabin during descent (angular rate sensor, over-load detector, temperature sensor, noise pickup, etc.);

— automatic landing systems;

— independent recorder of data on performance of devices and of physiological data on test animals during the period of descent;

— ejection capsule with two dogs.

Besides the two dogs the ejection capsule contained 12 mice, insects, plants, fungoid cultures, seeds of corn, wheat, peas, onion, some types of microbes and other biological objects.

Outside the ejection capsule, in the space cabin were 28 laboratory mice and two white rats.

The instrument compartment contained:

— radio-telemeter;

— flight control system;

— part of scientific investigations devices (instruments to study cosmic rays and short-wave radiation of the Sun);

— thermal control system;

— braking rocket.

Set up on the external surface of the space cabin were the steering jets, compressed gas cylinders of the orientation systems, pickups of scientific instruments, radio-antennas, experimental solar batteries, and a thermal insulation system to prevent burning of cabin during the descent. In the walls of the cabin are heat-resistant illuminators and air-tight hutches(quickly-opening).

Gas composition, humidity and temperature of air in the cabin, required for the normal life support of test animals, were provided by regeneration and thermal control systems.

Data transmission on the state of test animals, physical conditions in the cabin and in the instrument compartment, performance of devices aboard was accomplished by radio-telemetric system to ground measuring centers. The system operated in two regions:

a) direct transmission of telemetric information to ground centers at the moment of the spaceship flight above them;

b) Morazing (accumulation) of information with subsequent reproduction and transmission during the flight of spaceship above the measuring centers.

The spaceship carried radio-set "Signal", meant for a quick transmission of radio-telemetric information and improvement of radio-television communication with satellites.

A special TV camera was set up on board for transmission of test animal's pictures. The spaceship control was automatic, and also by commands from the Earth. Orbital control system of high precision was set up on board.

Power supply of devices was provided by chemical current sources and solar battery. The solar battery was arranged on two half-discs 1000 mm in diameter, oriented on the Sun by means of a special system, irrespective of the spaceship position.

SPACESHIP FLIGHT AND ITS RETURN TO EARTH:

After the spaceship was placed into prescribed orbit, it separated from the last stage of the carrier-rocket. During the flight all the main systems of the spaceship, scientific devices and TV camera operated in accordance with the prescribed program.

The spaceship was oriented during orbiting and descent by the orientation system. During operation of the orientation system one axis of the spaceship satellite was directed on the local vertical, the other - perpendicularly to the orbital plane, the third (longitudinal axis of spaceship) perpendicular to the first two and along the intersection of local horizontal plane and orbital plane (with exactly circular orbit - along velocity vector).

The flight of the spaceship satellite was observed from ground stations on the USSR territory. The obtained information was automatically transmitted into computing centers. The processing was on computers, as a result the exact orbital elements were obtained of the spaceship satellite, which assured the required forecastings of the ship's further orbiting and the possibility of its touchdown at prescribed point.

The demand for the accurate knowledge of the orbital elements is specified by the admissible errors in the landing of spaceship, since for the impact in prescribed area of landing the moment has to be selected for the switching of the braking rocket taking into account the actual coordinates and velocity of the spaceship at this moment. Error in velocity of the spaceship-satellite of 1 m/sec results in deviation of the landing by almost 50 km. Error in the actual altitute above the Earth surface by 100 m deviates the landing point by 4.5 km and the error in the direction of velocity vector to Earth surface by one minute results in deviation of landing point by 50-60 km.

In accordance with the orbital forecast data, and also with telemetric measurements, which characterized performance of apparatus on board, the coordination center by previously worked-out program controlled the spaceship satellite in space flight.

On the 18th revolution command was given from the Earth for descent of the spaceship with an estimate of its landing in prescribed area.

For descent of the spaceship-satellite from orbit to Earth its orbital velocity was reduced to the required one by means of the braking rocket.

The descent trajectory was selected in such a way, that the overstrain, originating with the entry of descending vehicle into dense atmospheric layers, and the time of their effect would not exceed the one admissible for living organisms.

After the transfer of spaceship to descent trajectory the instrument compartment was separated from the cabin and burnt during the entry.

During the descent the cabin was decelerated in the atmosphere by a special decelerating rocket. Descending to an altitutde of 7000 m, the cabin flew for about 11000 km after the start of descent. Maximum overstrain during deceleration of the cabin in atmosphere was 10 units.

At an altitude of 7000-8000 m the cover was thrown off of the ejection hatch on command from barometric relays and the capsule with animals was ejected from the space cabin. The landing of the capsule was at velocity of 6-8 m/sec, and of the space cabin - with velocity of 10 m/sec.

Fig: 1 - Flight and landing diagram of the second spaceship-satellite.

1 - deceleration by jet; 2 - descent trajectory; 3 - landing area of space cabin and ejected capsule.

Immediately after the capsule's ejection the radio bearing systems were switched on for direction finding of the cabin and capsule during the descent and landing. The landing of animals could have been done directly in the cabin, however, with the object of perfecting the ejection system, which is a reserve system of landing in future flights of man, the capsule with animals was ejected.

High precision of the spaceship landing indicates perfection of the control system in descent and high accuracy in determination of orbital elements by the measuring complex on the ground, errors of which affect directly the deviation of the landing point.

After landing, the space cabin and capsule with animals had no damages whatsoever which indicates high perfection of the landing systems.

ASSURING LIFE SUPPORTING CONDITIONS ON THE SPACESHIP:

One of the most important problems of successful conduct of biological experiments in the spaceship flight is the setting up and maintaining suitable conditions for the life support of living organisms.

ATMOSPHERIC CONDITIONS IN SPACE CABIN:

For the normal life support of animals certain atmospheric conditions are required in the cabin. Therefore, the main requirements of the hermetic space cabin were:

- maintenance of barometric pressure, similar to pressure on the sea level with concentration of oxygen 20-25% and carbon-dioxide not over 1%;

- maintenance of air temperature within 15-25 °C and relative humidity 30-70%;

- air decontamination of hermetic cabin from harmful admixtures, emanating during operation of the cabin's equipment, and also by animals in the process of their vital activity.

If the animals are placed into a closed unventilated space, as the cabin, the composition of air will quickly change due to their absorbtion of oxygen and emanation of carbon-dioxide and water vapors. Two dogs, like Belka and Strelka, consume 8-9 liters of oxygen per hour and release with respiration 6-7 liters of carbon dioxide per hour and 0.25 liters of water in 24 hours. Taking into account the fact, that normal vital activity of the dog becomes distrubed with reduction of oxygen content below 18% and increased quantity of carbon-dioxide upto 2-3%, it becomes obvious, that in the space cabin from the moment of its hermetization the animals could very quickly perish. In order to prevent this, the heavy composition of the cabin's air should be continuously restored.

To provide the life support to animals, normal pressure and temperature have to be maintained throughout the whole period of their being in the space cabin. In this connection it was necessary to draw off continuously the heat, emanated by animals and operating equipment of the spaceship.

In order to ensure throughout the whole flight period normal gas composition of the air, its temperature, pressure and humidity, an air-conditioning system was set up in the cabin of the second spaceship, which ensured maintenance of medium inside the spaceship within the preset limits.

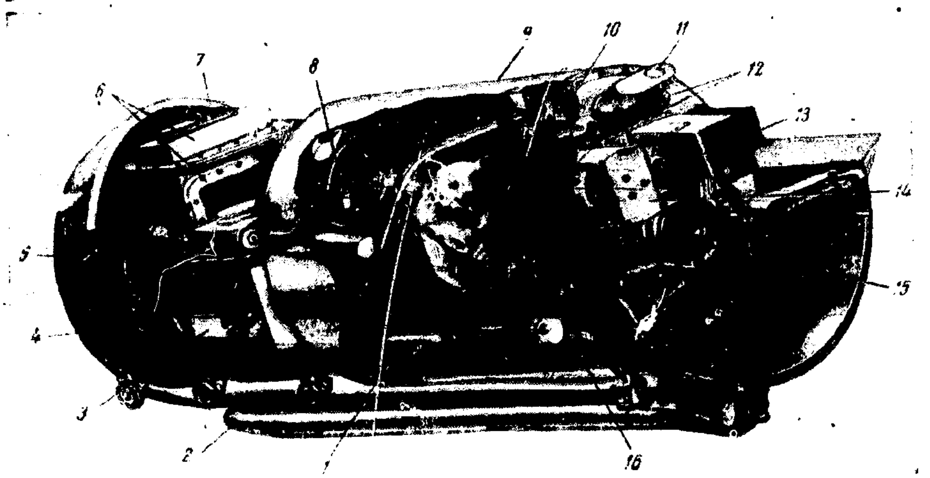

Fig: 2 - Hermetic cabin of animals in ejectable capsule on board the spaceship-satellite.

1 - cylinder of air system; 2 - ejection mechanism; 2 - radio bearing block; 4 - special accumulator battery for the heating of test tubes with microbes; 5 - storage battery; 6 - blocks of special scientific equipment; 7 - ejection capsule; 8 - movement transducer; 9 - hermetic cabin of the animal; 10 - microphone; 11 - radio bearing antenna; 12 - inhalation and outlet valves; 13 - TV camera; 14 - mirror; 15 - ventilation unit; 16 - feeding control.

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AIR AND PRESSURE CONTROL IN THE SPACE CABIN:

The required gas composition of air in the space cabin was maintained by a special unit. Analysis of the existing methods for air regeneration shows, that in flights with duration upto 15-20 days it is more rational to use highly-active chemical compounds, which absorb carbon dioxide and water vapors from the cabin's air and releasing an equivalent amount of oxygen.

Application of chemical compounds for air regeneration in small-size cabins has, however, some difficulties, one of which is the fact, that the oxygen release rate does not always conform to the oxygen requirement of the life forms. To maintain equilibrium between the release of oxygen and its consumption by the animals required construction of special units, automatically controlling the absorbtion rate of carbon dioxide and water vapors with release of the required quantity of oxygen. This automatic control of the regeneration process was implemented by quite simple and reliable construction of sensitive element, reacting to the change in operating conditions of regenerating unit as a whole.

The reduced quantity of oxygen and increased concentration of carbon dioxide was perceived by the sensor, which gave corresponding signals to telemetry and operating mechanism.

In the case of excessive release of oxygen there is also automatic operation of the active mechanism, as a result of which the air, fed into cabin, is only partially enriched by oxygen.

The prescribed air pressure was automatically maintained in the cabin. Specially developed filters reliably assured purification of the cabin's air in the case of its contamination by harmful chemical admixtures, released as a result of the animals vital activity and in the working of devices.

The operation of sensitive elements and parameters of air conditioning in the cabin were transmitted by telemetry to Earth.

The numerous experiments, conducted in laboratories, have shown, that the developed system of conditioning and regeneration has reliable maintained with the prescribed limits of barometric pressure, relative humidity, as well as concentration of oxygen and carbon dioxide in the air of hermetic cabin.

TEMPERATURE CONTROL IN THE CABIN AND IN THE INSTRUMENT COMPARTMENT:

Problem of creating required conditions of environment in the inhabited part of the cabin includes also maintenance of the prescribed air temperature.

The dogs and other animals, which accomplished the flight, are capable of enduring quite high fluctuations of ambient temperature. However, in the preparation of the flight the task was set of creating the most suitable temperature conditions. The fact is, that considerable deviations of environment conditions from normal place the animals in conditions of more or less considerable additional strain, requiring corresponding tension of physiological mechanisms, controlling the vital activities of organism in new, unusual conditions. This, in turn, would have created an unfavorable background for enduring the main conditions of space flight - overstrain, the state of weightlessness, etc. Therefore, the problem was to maintain the prescribed temperature of air with fluctuations within a very narrow range.

In the resolution of this problem it was necessary to overcome a number of difficulties, the majority of which are connected with invariability of heat liberation rate, specially by the animals and instruments. At the same time to maintain the temperature within the prescribed limits, the quantity of drawn off heat during each period should be in exact correspondence to its input.

To draw off heat from the space cabin the application was of a cooling unit with fluid and air radiator. The fluid cooling agent was fed into radiator from the thermal control system of the spaceship. The consumption of cooling agent was controlled in relation to the temperature in the cabin. This kind of system assured stable maintenance of air temperature in the cabin throughout the flight.

Maintenance of prescribed temperature in the instrument compartment and stable temperature of the cooling agent was accomplished by means of radiation heat exchanger and shutter system.

Heat from the hermetic instrument compartment, filled with gas, was drawn off directly onto the radiation heat exchanger, placed atop the body of the instrument compartment.

FEEDING AND WATER SUPPLY OF THE ANIMALS:

Feeding and watering of test animals during a prolonged flight on earth satellite was quite a problem, mainly due to weightlessness.

This makes it impossible to give the dog water in an open vessel, as the fluid could be carried off and become unobtainable to the animal.

Solid food, meant for feeding in conditions of weightlessness, should not crumble and break into pieces.

The simple and effective method for overcoming these difficulties is the use of viscous, jelly-like mixture, containing all the necessary nutrients in sufficient quantity and at the same time the required quantity of water.

This combined feeding of animals was used for the first time for biological experiment on the first earth satellite with the dog Laika.

On the basis of estimates and numerous experiments the following recipe was worked out for the combined nutritive mixture, corresponding to energy consumption of dogs upto 7 km in weight, which are confined in a small space for a considerable time, and providing daily requirements of the dog in water in conditions of temperature within 15-25°C.

This nutritive mixture has a gel-like consistency, having sufficient cohesion with the sides of the feed box and does not fall out with turning over in conditions of weightlessness.

An automatic feeder was constructed for the issue to test animals of the daily portion of the food mixture. Special appliance opened the lid of the feed bowl, thus enabling the dog to obtain the food.

Product	Quality, g	Proteins	Fats	Carbohydrate	Calories K Cal.
1. Meat (below average fatness)	80	15,89	2,74	-	90,6
2. Combined fat	30	-	28,36	-	263,7
3. Hercules cereal	10	0,91	0,6	6,1	34,3
4. Agar-agar	2	0,06	-	1,8	7,6
5. Water	188	-	-	-	-
6. Sausage	20	3,84	4,5	-	57,6
7. Vitamins C, P, A, B_1, B_2, PP, B_6	Below 1 g				
TOTAL:	331	20,7	36,2	7,9	453,6

To prevent the food mixture from going bad it was sterilized in autoclave at 115°C. This provided for its reliable conservation.

In the tests of the animal-feeding system in ground experiments it was fixed, that dogs, fed for a long time on combined mixture from the automatic feeder, did not lose weight and did not feel thirsty.

It should be mentioned, however, that the use of combined feeding required long and systematic training of animals in accordance with a special program in conditions, approximating flight conditions on a spaceship.

To provide life-support conditions for mice and rats special cages were constructed with sides of net. Along the sides were tubular feed-boxes with dry-food briquets, which contained all the necessary nutrients. The water was in a special little tank and was fed into the cage along a pipe with a wick. The mice and rats were earlier made used to this method of taking food.

EJECTION CAPSULE FOR ANIMALS:

The ejection capsule with the dogs Belka and Strelka, is one of the versions of capsules, developed for future flights of man.

The shape is selected with an estimate to ensure, after the ejection, a stable and correct position of the capsule axis in relation to velocity vector.

The following units and systems were arranged in the capsule:

- cabin for animals with trough, automatic feeder, sanitary arrangement, ventilation system, etc.;

- ejection and pyrotechnical equipment;

— radio-transmitters for radio bearing of the capsule;

— TV camera with lighting system and mirrors;

— blocks with nuclear photoemulsions.

The arrangement of systems is shown in Figure 2.

The animals cabin is made of sheet metal. Inside the cabin is the trough for disposition of animals, automatic feeder, sanitary arrangement. Arranged on the trough itself are the movement transducer and automatic gauge for measuring blood pressure of the animals. At the top panel, made in the shape of removable cabin cover, were arranged TV cameras, lighting system and mirrors, ventilator and block of containers with micro-organisms.

Fixed inside the cabin were the automatic feeder, containers for fine biological objects and microphone, enabling to judge the noise level in flight.

All the systems of ejection capsule with animals cabin were estimated for a prolonged space flight.

TELEVISION EQUIPMENT OF THE SPACESHIP:

Complete correlation of the data of physiological functions of test animals is very difficult, if the simultaneous observation of the test animals directly is not possible. TV system of the spaceship-satellite provided this possibility to physiologists. Pictures, transmitted from aboard, when the spaceship-satellite was in the zone of action of the ground reception centers, were recorded on cinefilm. Simultaneously on the same film time breaks were recorded, synchronous with time bre.ks, reproducible on telemetric film. Thus, by comparing the films it was possible to determine the behavior of the animal at a certain moment and what physiological changes were concomitant with one or another action of the animal. During the construction of TV equipment a number of contradictory requirements has arisen. On one hand, it wa: necessary to ensure high quality of pictures, on the other - to reduce as far as possible the weight, overall size and, specially, the energy consumption of the equipment. The scientific problem - transmission of information on behavior of animals and coordination of their movements - permitted to reduce considerably the parameters of TV picture: number of scanning lines, picture frequency - as thereby to narrow sharply the spectrum of the signal. Technical reasons were also taken into account - in the first experiment it was expedient to work in as narrow as possible frequency spectrum, so as to protect one self from possi..e frequency-phase distortions, which may emerge with transmission of spectrum of several megacycles per second.

The selection of these parameters made it possible to build up a highly-economical and reliable radio channel with high power reserve and satisfactory for the set task quality of picture.

Difficult was also the question of lighting up the animal. From the viewpoint of uniform lighting and creating most favorable light and technical conditions for teletransmission it was expedient to remove to a maximum extent the powe: ful illuminators, supplementing "duty lighting of the capsule".

There were two small-size TV cameras on board the spaceship. One, placed directly on the hatch of the capsule transmitted through the hatch window pictures of Belka in full face. The second camera was in the space cabin and transmitted through the side window in the capsule pictures of Strelka in profile.

The TV transmission begun even before the take off of the spaceship, the state of the animals was observed during the take off and at the moment of transition from overstrain to weightlessness and then at every revolution, when the spaceship satellite was in communication with any of the ground receiving centers. The cut-in and cut-off TV cameras and additional illumination was implemented on commands from the earth. The cameras were switched by turns. It was possible to switch-over the cameras at any moment of transmission. The ground stations, besides the arrangement for visual observation, had double recorders, in which every measure was taken to ensure highly-reliable recording.

The obtained TV films are of high scientific and cognitive interest, not mentioning the impression of the viewer, who could with "his own eyes" have a look at the outer space.

Great also is the purely technical significance of the first experiment in transmitting from space pictures of moving objects. This experiment has provided a most valuable experience, which will help in further development and improvement of the systems of subsequent space television. Television, as one of the basic means for cognition and mastering of space made one more important step in resolving this problem.

MEDICO-BIOLOGICAL INVESTIGATIONS:

The main problems of the medico-biological investigations on spaceship-satellite were the following:

— study of peculiarities in the vital activities of various animal and plant forms in conditions of space flight;

— biological effect investigation of the main factors of space flight on life forms (overstrain, prolonged weightlessness, transition from low ponderability to high and vice-versa);

— investigation of the effect of cosmic radiation on animal and plant forms (on the state of their vital activity and heredity);

— investigation of effective functioning of life support system in flight (regeneration, thermal control, feeding and watering, sanitation systems, etc.).

To resolve all this problems a number of biological objects were placed in ejection capsule and in the hermetic cabin.

In the hermetic space cabin there were three cages with 2 white laboratory rats, 15 black and 13 white mice. In ejection capsule there were two dogs (Strelka and Belka), a cage with 6 black and 6 white laboratory mice, few hundreds of insects (fruit fly Drosophila), two vessels with Tradescantia plant, seeds of various sorts of onion, pea, wheat, corn and Nigella, special vessels with actinomycetin fungi, monocellular algae-chlorella in fluid and on solid culture medium. 50 cartridges contained soldered ampoules with bacterial culture of Escherichia coli (type KK-12, B, "aerogenes"), bacillus in butyric fermentation, with staphylococcus culture, two varieties of phag (T-2 and 13-21), solution of desoxyribonucleic acid (DNA), and also with culture of epithelial tumor cells of man and small conserved skin sections of man and rabbit. Moreover, the ejection capsule contained 4 automatic bioelement with bacillus culture of butyric fermentation, 2 bioelements were in a special thermostat and 2 - in non-heated container.

The experiment envisaged and accomplished a considerable preparation work, including special methods of investigation, control and recording equipment, and also preliminary experiments, in which the effect was investigated of individual factors on the state of animal and plant forms, setting up of required background and control tests.

PHYSIOLOGICAL, BIOLOGICAL AND IMUNNOLOGICAL INVESTIGATIONS:

The main biological object, used in preparing biological experiment on the spaceship satellite, were the traditional laboratory animals - dogs, normal physiology of which is well studied. These animals are easily trained and are stable against various physical effects. The methods, used at present, make it possible with sufficient accuracy and convenience to record in dogs various physiological indices.

The test animals had to meet a whole set of requirements. The selection for experiment was of mature dogs from one and a half to three years of age. The size of dogs had to assure sufficient freedom of movement in the cabin; color - qualitative and contrast observation of the animals movement on TV. Preference were given to the so called "pye-dogs", which are highly immune to effects of various external conditions. A great significance was attributed to the type of nervous activity: the dogs were picked of strong, balanced, mobile type, in which conditional reflexes, required for experiment, were easily developed.

The animals were subjected to a thorough physiological and veterinary examination. To record the arterial pressure the carotid artery was brought out into skin flap on the neck. For a sure recording of the heart's bio-currents electrodes, made of special alloy, were implanted under the skin.

It is well known, that during the flight on a spaceship the test animals had to encounter a whole series of unusual factors: high acceleration, vibration, noise, prolonged stay in hermetic cabin, obtaining food automatically, implementation of the organism's natural functions in special clothes.

In order to be prepared for experiment the dogs were trained for a long time in the model of a space cabin with fixation system, which enabled the animals to move enough for normal vital activity. The period of dogs being in fixed position was gradually increased. The dogs were trained to carry sensors, fixing clothes and sanitary equipment. The dogs were also trained to eat the specially prepared mixtures out of automatic equipment, to which, as a rule, the dogs got quickly and easily used. During the preparation of animals a great number of investigations was conducted on stability determination of animals to acceleration. Each of the selected test animals was subjected several times to effect of acceleration on a special bench, which enabled to create accelerations, which would be met during the space flight. Test results have made it possible to state, that the test animals have satisfactorily endured overstrain with insignificant individual variations of physiological parameters, not outside the limits, however, of the compensatory facilities of the organism.

It is well known, that in the area of placing the spaceship satellite into orbit the animal's organism is subjected to the effect of vibrations, which could have affected in some way the state of the animal. To elucidate this question experiments were conducted, from results of which it is possible to speak of satisfactory enduring of vibrations by animals which may be expected during the flight. Besides, in the separate series of experiments individual immunity was investigated of the animals to impact strains (estimated for the case of the capsule's ejection), low barometric pressure, effect of extremely high and low temperatures of environment.

On completion of the whole cycle of preparation and tests, the dogs Belka and Strelka were picked for the flying experiment.

Strelka is a bitch of light color with dark spots, weighing five and a half kilograms, thirty two centimeters in height, fifty centimeters in length.

Fig: 3 - Belka.

Both the dogs have satisfactorily passed the preliminary selection tests and training and were then placed into conditions of pre-flight regime.

To control the state of the animals in flight and resolution of physiological problems of experiment a special set of medical investigation devices was developed. These devices recorded physiological functions of animals during the whole flight of the spaceship.

The following physiological indices were recorded during the flight: arterial pressure, electrocardiogram, heart tones, respiration rate, body temperature, motorial activity of the animals. Radio-telemetric systems transmitted to Earth information on barometric pressure, temperature and humidity in hermetic cabin, as well as the check data on functioning of the life supporting systems.

Considering, that the main object of experiments with animals is the preparation for a maned space flight, a lot of attention was paid to the questions, connected with the study of the motory apparatus of the animals, in particular to coordination of voluntary movements.

Television and special movement transducers were used for this object. In comparison to previously used motion-picture filming television has a number of serious advantages. It permits to observe the animals during the actual flight, eliminates the need for keeping a lot of film on board and does not require such high illumination as cine-filming. Moreover, it excludes the possibility of losing the material in some extreme circumstances.

A communique has already been issued to the press about the observation of animals in flight by means of television, and individual pictures of the films made were published. These films permit to judge not only the behavior of animals in space flight, but combined with information from the movement transducers could provide data for judging the state of the highest functions of the central nervous system and about the adaptation of animals to condition of weightlessness. Moreover, due to the presence on television films of the synchronizing system marks, each movement of the animal could be tied with high accuracy to any values of physiological functions available at the moment.

In the cabin with animals close to the dogs, as well as on the clothes of Belka and Strelka, individual dosimeters were fixed for measuring ionizing radiation. Dosimeters, returned to Earth jointly with animals after processing of their reading will provide information of the effect on animals of charged particles, electromagnetic radiation and of neutrons, included in the composition of cosmic radiation.

Fig: 4 - Strelka.

Study and estimate of the biological effect of various factors, connected with the space flight, and primarily the study of the biological effect of cosmic radiation, represent a most composite and multisided problem, requiring the use of most diverse investigation methods: physical, general clinical, physiological, biochemical, microbiological, immunological, genetic, etc.

Investigation of changes in metabolism is of great interest. It is important to elucidate, whether the changes in this case are insignificant and reversible or lasting shifts in metabolism. With this object a selection was made of a set of biochemical indices, characterising functions of liver, endocrine and nervous systems and considerably changing with high strain on the organism, as well as under the effect of ionizing radiation. For some months prior to flight, as well as in conditions of training to effects of individual flight factors (acceleration, vibration) the following indices were investigated in dogs of albumin composition of blood, some ferments and hormones in blood and urine:

— albuminous fractions of blood serum,

— serumal mucoid,

— cholinesterase activity of blood,

— desoxycytidin in urine.

All the listed indices are being investigated at present in dogs, returned from the space flight. Some of these indices are being investigated also in rats and mice.

A serious problem presented investigation of the cardio-vascular system condition in animals, which accomplished space flight. The activity of heart and peripheric vessels during the flight and on return to Earth could be affected by cosmic radiation, overstrain, weightlessness and some other factors. Because of this it seemed important to study in dogs of a number of indices of the peripheric vessels condition before and after the flight. Before the flight the dogs were examined for several months. The investigation in bloodless test was of arterial and venous tonus, vascular reaction to compression, and also the skin temperature. After the return to Earth thorough investigation was made in dogs of their cardio-vascular systems and, in particular, the state of peripheric vessels. The preliminary results of examining Belks and Strelka after the return to Earth show no appreciable changes.

The immunological reaction study of the test dogs was the next important probl m. It was necessary to elucidate, whether the effect of cosmic radiation and other flight factors will cause depression in natural immunity to microbes and because of this development of infectious processes. This is all the more important, as the spacemen in future will be confined for a long time within the limits of the spaceship.

The following were investigated in dogs before and after the flight:

— phagocytic and bactericidal function of blood,

— bactericidal properties and natural microflora of the skin.

The effect on the dogs under the conditions of accelerations and vibrations were also investigated on the earth.

For an allround study of various functional changes, taking place in a life during the flight, it is expedient to to obtain data on a number of animals as large as possible. With this object, besides the dogs, two white rats and mice were also used.

The work on rats was begun some months prior to flight. By means of conditional reflex methods the highest nervous activity of these animals was used, typological characteristics were determined, blood analysis carried out, electrocardiogram recorded.

Even the first investigations after return to the earth have shown, that rats, just as the dogs, have endured well the flight. During the flight they were well taking fodder, stored in feed-boxes. Careful examination of the rats found no scratches or contusions. The animals have lost no weight, were normally mobile. Further investigations will supplement our information on the effect of space flight on the highest nervous activity of these animals.

Besides the general clinical examination, including blood study of the mice and rats, a detailed investigation of the bone marrow of mice was conducted on their return to earth. This investigation will permit to draw conclusions on the effect of space flight conditions, and primarily of the effect of cosmic radiation on the hemopoietic functions of the organism. Mice, returned from the flight, will be gradually, according to a certain program, subjected to a careful and regular pathoanatomical and histological investigations. These investigations will help to detect morphological changes in the organs and tissues of life form, if these have set in during the space flight.

MICROBIOLOGICAL AND CYTOLOGICAL INVESTIGATIONS:

The program of biological investigations on the second spaceship-satellite envisaged also application of microbiological and cytological investigation methods. These methods permit to resolve effectively such important problems, as the determination of limiting period living cells being in space, their growth and development in these conditions, since the elucidation of this kind of questions by means of large animals is difficult. These methods are applicable also for the study of genetic effects of space factors, in particular of cosmic rays.

Characterization of genetic effect of these radiations should be an allround, and therefore besides the use of animals (for instance, mouse-like rodents, insects, etc.) it is possible to use also micro-organisms and living cells of human body in tissue culture. Both have certain advantages due to high rate of propagation and correspondingly quick change of generations. Moreover, study of the changes in the properties of micro-organisms, specially such constant "satellites" of man, as Bacillus coli and Staphylococcus, has an important significance for judging their behavior in the organism of future spacemen. As regards the living cells outside the organism in tissue cultures, the genetic changes came on in them considerably more frequently with the effect of the same levels of radiation. However, the shortcomings of this method is the difficulty of preserving the vitality of these delicate cultures outside the immediate control of a man.

The use on the second spaceship of both these objects envisaged reciprocal compensation of these shortcomings.

In modern genetic investigations special attention as an object is attracted by bacteriophage - supermicroscopic living forms, parasiting on bacteria and entering with them into composite genetic relations. Specially sensitive indicators of genetic effect of radiation are the so called lysogenic bacteria, capable with irradiation to produce bacteriophage. A certain interest was represented also by the study of the effect on the growth and development of this kind of living cells of acceleration, weightlessness, vibration, etc.

In accordance with these reasonings the second spaceship-satellite carried various microbiological and cytological objects. These were prepared specially for this test, moreover, the selection of object was guided by the striving to pick organisms, widely used in laboratories of the whole world, in order to obtain comparable results. Among the objects were the cultures of Bacillus coli KK-12, for which the initial strain were the well known to microbiologists bacteria, having the most clearly defined genetic characteristic.

This permits to determine quantitatively the extent of genetic changes and to compare these values with the level of radiation and quality of cosmic particles, recorded on the spaceship-satellite by physical devices.

By means of a long and careful study, begun at present, of the returned cultures, it will, probably, be possible to define the extent of change in the number of the so called induced mutations, i.e., in majority of pathological changes in hereditary properties. Moreover, there is a possibility to investigate these cultures with the object of fixing the effect of radiation on the number of bacteriophage produced by them.

The varieties of Bacillus coli - "B" and "aerogenes", used in the test, are also objects for the study of mutations rate.

For investigating the genetic changes in the minutest living forms - bacteriophage - the use was made of strain T-2, also well known and genetically characterised fully. It may be expected, that in the case of presence during the flight of the second spaceship-satellite of sufficient rise in the level of radiation genetic changes could be noted in individual species of bacteriophage strain under investigation, ascertained both by the effect of these bacteriophage on bacteria and by way of determination of other biological properties. Besides the T-2 the strain was used of bacteriophage 13-21, specifically affecting Bacillus coli of the "aerogenes" type. It was meant for investigating the changes in the nature of lysis (dissolution of bacteria, which occurs in the presence of bacteriophage).

This process for the phag system 13-21 - Bacillus coli "aerogenes" was earlier documented by means of ceitrapheric microfilming and electronic microscopy.

In respect of all the indicated organisms a detailed physiological-structure characteristics were obtained beforehand by means of the latest methods. In particular, Bacillus coli and staphylococcus, which were also exposed on the spaceship-satellite, were investigated under the electronic microscope partially by means of ultrafine microscopic sections.

During the preparation of medico-biological experiments on the spaceship-satellite the use of ultrafine microscopic sections of free and intracellular bacteriophage was made for the first time. Therewith it has been fixed, that the used bacteriophage resemble particles, consisting of a central nucleus of high electronic-optical density and peripheric zone, separated from the nucleus by the finest membrane.

As regards the test butyric acid bacteria, they were used only to develop methods for automatic viability recording of micro-organisms. These methods will assure the possibility of determining the longevity of the cells on long-flying and non-returning satellites and rockets. The test of butyric bacillus in this respect was fully justified.

On this basis methods and special devices were created and approved, which permit to record and transmit to the Earth signals, characterizing viability and physiological functions of the smallest life forms - bacteria during any flight duration of a satellite or rockets.

Automatic devices tested on the spaceship-satellite and based on these principles, extend to a considerable extent the possibilities of investigating biological conditions in the outer space, since they are of small size and weight, and the test objects confined in them (spores of butyric acid bacillus) do not need supplementing the system by nutrients.

Bioelements after any exposure during the flight could be activated on signals from the earth or from the programing device on board.

As has already been stated, besides the many advantages of microbes in medico-biological and in particular genetic investigations, they have a very considerable defect - low radio-sensitivity. In order to rise their radio-sensitivity a part of the microbiological objects were in the oxygen atmosphere. Moreover, on the second spaceship-satellite an attempt was made for genetic characterization of the outer space to use also living cells in tissue culture. It is well known, that heredity in these cells changes under the effect of radiations hundred times easier, than in microbes. However to preserve their viability during a long time without transplanting to new cultures is very difficult. This attempt required picking well-growing cells and appropriate cultures. Taking this into account the use on spaceship-satellite was made of cancer cells. These cells grow well on artificial medium and are widely applied for the study of genetic problems and investigation of the nature of cancer.

These cells were cultivated by the method, which permits to obtain colonies of cells on the sides of glass test tubes, where the cultivation is being accomplished.

It was established in preliminary tests, that the cancer-cell colonies are attached to the sides of glass test tubes and ampoules with such tenacity, that they can withstand vibrations, considerably exceeding those, which take place in the launching of modern rockets. This makes it possible in material processing to give bio-morphological characteristics of cultures, development cycle of which passed partially in a specially arranged small thermostat aboard the spaceship-satellite.

The viability of these cultures is being determined at present and measures are being taken for maintaining them in subsequent transplants. In the case of positive results the cultures will be used to study their hereditary indications in comparison to check cultures, which remained on earth.

Small sections of human and rabbit skin were also exposed on the spaceship-satellite. The use of the human skin pieces, provided by volunteers out of the groups of authors, participating in space investigations, was made with the object of elucidating the possible effect of space factors on specially sensitive cellular systems. The proof, that the skin pieces have returned alive, could be the histological investigations, planting of crushed pieces of skin on special cultures, although this cultivation is usually very difficult, and, finally, their reverse grafting to donors, in which they were taken. The skin pieces, returned after flight on the spaceship satellite, are being thoroughly investigated at present.

In our time biological including genetic investigations are being carried out in close relation with the physico-chemical research. In particular, during the last decade it was shown, that chemical substances may participate in transmitting hereditary indications from one variety to another. This chemical substance is the desoxyribonucleic acid (DNA), included in the nuclear composition of cells in animals, plants and microbes. It is quite possible, that this compound will be the first to react to genetic effect of the cosmic radiation. Taking this into account ampoules were placed on spaceship-satellite with desoxyribonucleic acid, obtained from a thyroid gland of a calf, moreover a part of the ampoules were filled with oxygen. In the investigation of returned desoxyribonucleic acid modern methods will be used, which permit to characterise the state of this compound in physio-chemical respect. Comparative short orbiting period of the second spaceship-satellite makes it possible to think, that no rough deviations will be discovered in desoxyribonucleic acid. Nevertheless attempts will be made to detect the subtlest changes by means of physico-chemical, immunological and other methods.

The first test of exposing in the outer space biologically active chemical substance will be used for composing a more extensive program of biochemical investigations, the course of biochemical reactions in space conditions, and also the search in the outer space of organic matter and its predecessors.

Thus, a number of objective experiments was accomplished aboard the spaceship-satellite with animal cells, micro-organisms, bacteriophage in composite organic molecules in order to make everything possible for resolving the question of the viability of the cells and radio-genetic safety in the outer space. It is expected, that data, which will be subsequently obtained in processing of this material, in comparison with similar data, defined in the investigations of animals and insects, will enable to characterise more fully biological specificities of the outer space.

GENETIC INVESTIGATIONS:

Besides elucidating the effects of space flight factors, primarily of cosmic radiation, on the physiology of organisms, investigations were also initiated of the effect of these factors on heredity, and of genetic danger of space flights.

Numerous investigations of Soviet and other countries scientists have established, that the types of ionizing radiation, as X-rays, gamma-rays, high-energy neutrons and some other, represent a powerful source of hereditary changes in all organisms, including a man.

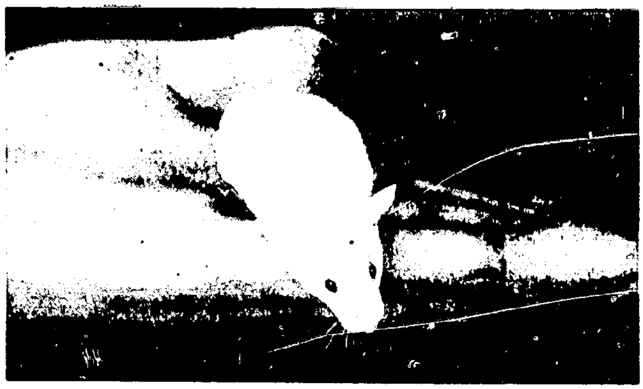

Fig: 5 - White mouse of the laboratory.

Experiments with irradiation of human tissues by X-rays have shown, that a dose of 10 roentgen doubles mutation rate. It has been defined, that various types of ionizing radiation have different biological effectivity. For instance, fast neutrons cause one and a half to two times more mutations, than X-rays or gamma-rays. The genetic effect of the primary cosmic radiation was impossible to study until now. The flight of the second spaceship-satellite has finally provided the opportunity for this type of investigation.

Although an overwhelming number of mutations is harmful, some of them in certain conditions of environment could be useful for the species. These useful mutations play an important role in the evolution of organic world and in creating new highly-productive strains of micro-organisms and sorts of cultivated plants. Radioselection of micro-organisms and plants during the previous years has become one of the investigation branch for selectors. Therefore besides elucidating the genetic danger of cosmic radiation it is also necessary to elucidate the possibility of its use for radioselection.

The spaceship-satellite carried the following species of organisms, marked for prior genetic investigations: mice of two different types, fruit flies Drosophila also of two different types, two tradescantia plants, wheat grains of 186 sort, seeds of three sorts of pea, distinct in radio-immunity, two sorts of corn - "nemchinovskii" and "podmoskovanaya", Welsh onion and Nigella; actinomycelin fungi - producers of antibiotics. What explains the selection of precisely these objects for the first genetic investigations, connected with space flights?

The mice and Drosophila due to a number of biological specifics - high rate of propagation and changes of generations, their easy breeding, and also due to great diversity of their indications, inheritance of which is well studied, they are very convenient for genetic investigations. Mice, which have been in the outer space, will be subjected to detailed cytological analysis in order to define those changes, that could have taken place in the cells of various tissues under the effect of cosmic rays. Primarily the detailed investigation will be of the state of the chromosome apparatus of the homopoietic organs.

As mentioned above, Drosophila of two types have participated in tho flight. One of them D-32 - is distinct by very low mutability in natural conditions, the other D-18 - on the contrary is of very high natural mutability. Tests will be set up with flies on special methods of cross-breeding, which will clarify the rate of emerging in both the species of the most important types of harmful mutations (the so called recessive and dominant details).

The tradescantia plant is a classical object of cytological investigations, as it has a small number of clearly distinct one from another chromosomes. Plants with buds were specially set up in the cabin with animals, since the chromosome reconstructions in Tradescantia is easiest to observe in cells, separating with pollen formation.

The dry seeds of cultivated plants - wheat, corn, pea - will be screened in order to find out whether and what mutations precisely causes cosmic radiation in various species and sorts of plants.

As regards the onion and Nigella, these will be used mainly for cytological investigations.

The ionizing radiation is widely used for obtaining new, more productive strains of actinomycetis, producing such valuable antibiotics as penicillin, streptomycin, etc. Two strains of fungi - producers of penicillin, highly distinct in radiosensitivity were placed on the s_aceship. Investigation of their irradiation results in space will enable to resolve the question regarding biological effectivity of cosmic radiation in respect of this, very important object.

Fig: 6 - Vessel with Tradescantia plant.

It should be pointed out, that each of the listed genetic tests is combined with exact check tests with the same objects in the conditions usual for them. This will assure an objective estimate of the results of genetic investigations. These investigations are only just beginning and, undoubtedly, they will be continued and will become an indispensable very important part of work, connected with further space flights. Cognisance of hereditary laws and their control is one of the most important problems of the study of present nature. The entry of man into space marks the beginning of new chapter in the development of genetics, chapter dealing with the knowledge of the cosmic flight factors effect on heredity and evolution, development of protection methods against the harmful effects of these factors and the use of their positive effects. The genetic investigations on the second spaceship-satellite are only the first steps in this direction.

In the plan of the prolonged flights of the future the problem is very acute of the air regeneration in hermetic cabins and providing the crews of the spaceship with food. Even the simple calculations show, that the use with this object of chemical reagents and food stuff, taken from the earth, would have resulted in very high initial weight of the spaceship, since in this case the reagents and food taken from the earth will not become replenished with their consumption on the way. At the same time in the scale of our planet these processes - absorbtion of carbon dioxide, separation of oxygen and synthesis of composite organic matter out of the fully oxidized - are implemented in the leaves of green plants as a result of photosynthesis.

Therefore the necessity was assumed of creating on spaceships for air regeneration and obtaining of food hothouses of green plants, which by absorbing the carbodioxide, excreted by life forms, would reconstruct food and excrete oxygen. The most suitable for this purpose were found to be the microscopic green algae, which develop very fast, are distinct by high-activity photosynthesis and a number of other very valuable qualities.

These reasons determined the need to study the effect of space flight conditions on the viability of green algae. The chlorella on board the spaceship was placed into special ampoules in different physiological conditions: on slanting agar and on fluid culture at different density of suspensions. Moreover the algae was kept both in light and in darkness. The obtained material is being subjected to detailed analysis. Study is being conducted of the general state of suspensions, morphology of the cells, activity of photosynthesis, the growth and development of culture, changes in hereditary properties of cultures.

Even now it is possible to say, that the biological experiment on the second spaceship-satellite is a very considerable contribution to the study and mastering of the outer space by a man.

All the numerous biological objects, who flew in the spaceship, have returned to earth alive and in good condition. The state of the dogs Belka and Strelka, of mice, rats and other biological objects, according to preliminary data, define no noticeable departures of the available material is being carried out.

The obtained results indicate, that life support systems and means developed by the Soviet scientist for providing the safety of flight and return from space flight of animals and man, are quite justified.

SCIENTIFIC INVESTIGATIONS ON THE SPACESHIP: INVESTIGATION OF COSMIC RAYS

The question regarding composition of the primary cosmic radiation is closely connected with the problem of cosmic rays origin, with generation mechanism of cosmic radiation and propagation of cosmic rays in the interstellar medium.

The second spaceship carried apparatus, by means of which it is possible to obtain data on the composition of cosmic rays in the range of nuclei from helium to oxygen. For this the use was made Cherenkov counters, controlled by telescopic arrangement of halogen gas-dis-charging counters.

With the passage of cosmic ray particles through this device at a prescribed solid angle operated the coincidence circuit, the impulse in which opened out photomultiplier channel. From the collector of photomultiplier issued a signal, originating with the flying-through of a nucleus, which caused luminance in detecting Cherrenkov counter. Impulse amplitute at the output of Cherenkov counter is proportional to the square of the charge on the nucleus. By means of a special device signals of various amplitudes were converted into signals of corresponding duration superposed on which were impulses from a standard generator. The number of impulses, filling each signal, was counted by the counting circuit and transmitted to telemetric system.

At present there are no exact data available regarding the ratio of the nuclei flux of carbon nitrogen, oxygen group to the nuclei flux of lithium, berillium, boron group (the most interesting from the viewpoint of the cosmic rays origin). As a result it does not seem possible to draw final conclusion about a definite production mechanism of the nuclei and the movement of accelerating particles in the interplanetary space. In order to obtain new data in this sphere it is necessary to know the flux ratio of the above groups of nuclei with high accuracy.

Alongwith this the measurements of heavier nuclei flux were conducted. The integral Cherenkov counter measured flux of nuclei with charge over five, fifteen and thirty. Measurements conducted on the second Soviet space rocket enabled to fix by this method the cases of high increment (10 times) in the flux density of nuclei with charge over fifteen, correlated with radio-emission of the sun, moreover the fixed relativistic nuclei escaped from the sun in compact groups. This fact has shown for the first time, that the sun is capable of producing relativistic nuclei, in which case the accelerating one are mainly the heavy nuclei. Further study of these processes will make it possible to understand the bond of the solar radio-emission with cosmic rays, and also to unravel the mechanism of cosmic rays production by the sun.

The flight of the second spaceship and its return to earth enabled to obtain in the outer space photographs of those processes, which take place in the microcosm. Nuclear photo-emulsions were used for this purpose. Peneterating through these emulsions, particles of cosmic rays collide with atomic nuclei. As a result of these collisions there is not only the destruction of the atomic nuclei, but also the birth of new particles. The emerging particles undergo a number of transformations. New acts occur in the emulsion of the interaction of particles, created as a result of the first collision, with atomic nuclei of the substance.

What laws govern all these phenomena? It has not as yet been established upto now. To uncover the mysteries of matter, the need is first of all to obtain detailed information on all those processes, which occur in the microcosm. By means of nuclear photoemulsions it is possible to obtain quite detailed photographs of these phenomena. Examining the photoemulsion through a microscope it is possible to reconstruct the picture of processes, taking place during a billionth fraction of a second.

Cosmic ray particles of high energy intensely interact with matter. Therefore in the invasion of cosmic particle into atmosphere it gets quickly overgrown with a swarm of secondary particles, which it has created. Because of this the investigations have to be conducted beyond the earth's atmosphere. At the same time the emulsion sent into space should return to laboratory completely intact.

It is known, that gigantic accelerators, constructed on earth make it possible to obtain particles with energy below a certain limit. There are particles in cosmic rays with energy million times higher.

Lifting of nuclear photoemulsions into the outer space will enable to use effectively this enormous accelerator, existing in nature.

The second spaceship carried several blocks of thick-layered nuclear photoemulsions, moreover in one of them it was envisaged direct developing of photoemulsions on board the spaceship. Development of the photoemulsions aboard after the present exposure (about 10 hrs) allows to separate more reliably traces of individual nuclei against the general background of cosmic radiation.

The autonomous programing device of photoemulsion block gives after a preset time a command, at which the piston inside the cylinder draws apart the exposed layers and at the same time lets in the developer. The developing continues for 90 minutes, thereafter the programing device gives a command for removal of developer, which it implement by a reverse motion of the piston, which compresses the layers. Then follows the command for the drawing apart of the layers and the feeding in of preserving solution. In this solution the layers may be kept for several months upto the final processing of the photo-layers. In processing the traces should be studied from relativistic nuclei of the primary cosmic radiation and information obtained regarding the quantitative flux ratio of various groups of nuclei.

There were another three blocks on the spaceship filled with thick-layered nuclear photo-emulsion, not being developed during the flight.

Block FE-2, meant for recording elementary processes of nuclear interaction of high energy particles (in the region of 10^{12} electron-volts and higher), contained an emulsion stack, composed of many layers of nuclear photoemulsion. The thickness of each layer was 400 microns size - 10x10 cm. Placed between the emulsion layers were thin about 1 mm, "targets" of light-weight substance.

The presence in nuclear emulsion of silver and bromide atoms and the "targets" of light substance make it possible to record interaction cases of high-energy nucleons both with heavy emulsion nuclei and with the light nuclei of the placed targets.

Produced in the nuclear interaction of high-energy particles neutral mesons initiate the photon showers, for recording of which a special detector was fitted in FE-2 under the emulsion stack. This detector was made up of 7 lead plates each 5 mm in thickness (which corresponds to one shower length unit). Between the lead plates were placed the nuclear emulsion and luminescent shower indicators, simplifying the detection of the concrete acts of interaction.

Analysis of the cases of electron-photon showers, recorded in the nuclear emulsion, provides their quantitative characteristics, including energy, transmitted during the inter-action to mesons. Knowledge of this energy, as well as he analysis of corresponding events, recorded in emulsion stack, makes it possible to determine some parameters of the given nuclear interaction.

Thus, comparison of obtained quantitative characteristics for interaction of high-energy particles of the primary cosmic radiation with light and heavy nuclei will enable to define the specifics and to draw a certain conclusion regarding the mechanism of this interaction. Of special interest here will be to define the nature of interaction of high-energy multi-charge particles, investigation of which does not seem possible in terrestrial conditions. To investigate the multicharge particles in the composition of primary cosmic rays, photo-blocks F-1 and F-2 were set up aboard the spaceship. These blocks were the emulsion stacks 0.8 liter each.

At present the emulsions are being processed in laboratories. One of the microphotographs of typical nuclear interaction, recorded in emulsion aboard the spaceship, is shown in Fig. 7.

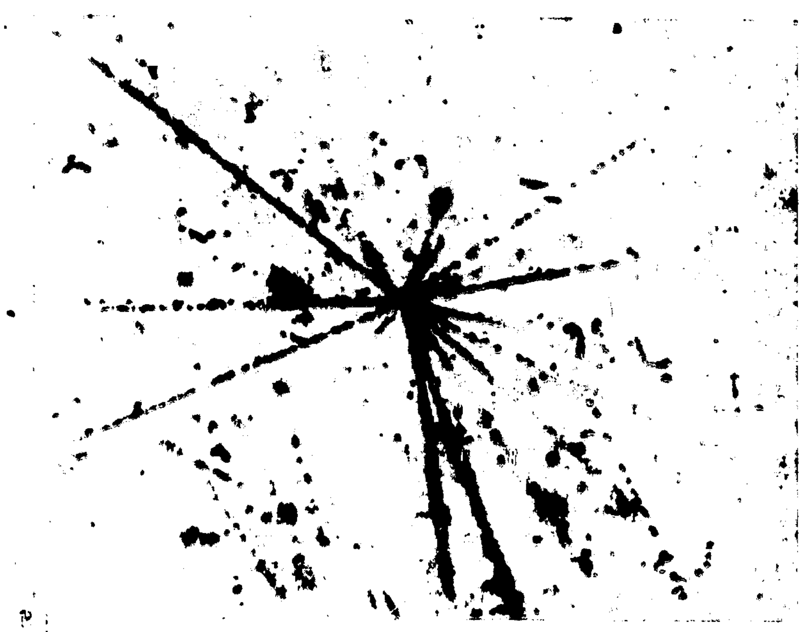

Fig. 7

RECORDING OF COSMIC RAY DOSES:

The presence in the interplanetary space of cosmic rays and radiation zones in the vicinity of the earth is a real danger for the flights of future travellers into the interplanetary space.

Cosmic rays, consisting of high-energy charged particles, similar to any other ionizing radiation, are, undoubtedly, biologically dangerous. However, due to the fact, that the number of cosmic ray particles beyond the earth atmosphere is low (2 particles per one square cm per second), the radiation dose built up by them is relatively not high (about 100 milliroentgen per day, which is only twice higher the admissible dose, as assumed at present).

Recently it has been experimentally proved, that sometimes there is temporary increment of cosmic rays, connected, most probably, with the solar activity.

It has been fixed, that at the moment of cosmic ray flares its intensity increases thousand times. In this case the radiation dose increases upto tens of roentgens per hour, which is already a real radiation danger.

So far it was not possible to fix any regularity in the fare times of cosmic rays.

However, the protection from solar flares of cosmic radiation seems quite realistic.

As we know, there is the existence of radiation belts, representing zones of high-intensity radiation, composed of charged particles, trapped by the magnetic field of the earth.

Investigations, conducted on artificial satellites, have established, that there are two circumterrestrial zones of high-intensity radiation. The external radiation zone extends in the equatorial plane from 14 thousand km to 50-55 thousand km from the earth surface. In the interval of 55-70^{o} of geomagnetic latitudes the external zone comes down to 270-300 km.

In composition of radiation the external zone consists of electrons of wide energy spectrum. The flux of electrons in all directions contains, according data of various authors, 10^{8}-10^{10} particles per sq.cm/sec.

This flux of electrons may build-up a surface dose of about 10^{6} roentgen per hour. However, the electrons of the external radiation zone are easily absorbed, and even under the protection of one gram of light substance per sq.cm. of surface the radiation dose in this zone will compose only some tens of roentgens per hour.

Thus, a very insignificant protection may reduce the radiation danger in external zone to a minimum. At the same time prolonged presence within the peak intensity region of the external zone could be dangerous.

Experiments conducted on space rockets fixed, that the boundary and radiation peak in the external zone are time-variable. This creates additional difficulties in estimating the radiation effect in space flights. Therefore, one of the most important porblems is a long-term observation of the external zone boundary and its radiation activity, specially in the region of high geomagnetic latitudes.

The internal radiation zone lies at altitudes from 600 to 5000 km from the earth surface. Particles, included in the composition of internal zone, are mainly protons with energy upto 100 million electron-volts. There are also electrons with energy not above 10^6 electron-volts. Radiation within the internal zone is harder, than in the external. Radiation dose under the protection of one gram of light substance per sq.cm. of surface composes here about 10 roentgen an hour and very gradually decreases with increased protection.

In contrast to external zone the radiation within the internal zone is time-stable. The radiation protection in this zone requires application of considerably greater quantity of substance. Prolonged flight within the internal zone without special protection are bound with considerable radiation danger.

Thus, boundary instability of radiation belts and random activity increments of cosmic radiation make very necessary level control of cosmic radiation and detailed study of the lower boundaries of radiation belts.

To resolve the indicated problems a dosimeter (radiometer) was set up aboard the spaceship.

The composition of radiometer includes two gas-discharging and two scintillation counters. One of the gas-discharging counters is placed under the additional absorber (screen), consisting of brass and iron. The scintillation counter with photomultiplier and sodium iodine crystal 30x15 mm were placed in the same block with gas-discharging counters. The other scintillation counter with photomultiplier and cesium iodide crystal 2mm in thickness was placed outside. To prevent the effect on counter of the visible light, the cesium iodide crystal was covered by an aluminium foil 7 microns in thickness.

The gas-discharging counters, as well as the scintillation counter with sodium iodide crystal provide information on the number of particles, which passed through them. At the same time the scintillation counters enable to judge the total ionization, caused by the passing particles.

Information obtained both on the number of particles, which passed through, and of the total ionization caused by these particles in crystals, will provide quantitative data about the level (dose) of radiation.

INVESTIGATIONS OF THE ULTRAVIOLET AND X-RAY RADIATION OF THE SUN:

As we know, the sun radiates energy in a very wide interval of wavelengths. However, only a small spectrum region of this radiation, filtered through the earth atmosphere, reaches the observer on the ground. From the short-wave side of the spectrum the transmittance limit of earth atmosphere lies in the vicinity of 2900 angstrom (1 angstrom = 10^{-8}cm).

The whole of the short-wave radiation below this limit is absorbed by the earth atmosphere and penetrates only upto altitudes of about 70 km above the earth surface. Investigation of the short-wave radiation is of considerable scientific and practical interest. Concentrated in this region of spectrum in the main radiation of the solar corona and of the chromosphere - little known external envelopes of the sun. This radiation at the same time causes certain processes occuring in the earth atmosphere, in particular, formation of ionosphere.

The most interesting radiation of the sun's chromosphere in the short-wave region of spectrum is concentrated in the spectral lines of hydrogen and helium. The most intensive of these lines is the hydrogen line with wavelength 1216 angstrom, the so called Lyman-alphaline. The main radiation of the solar corona is concentrated in the region of soft X-ray radiation - shorter than 200 angstrom units upto a few angstrom units. This radiation consists of a continuous spectrum, specified by the inhibition of electrons in the field of ions, and of spectral lines, belonging to highly-ionized atoms of iron, oxygen, nitrogen and other elements composing the corona.

The solar corona is not a single formation. It is possible to define within it regions, not corresponding to the calm corona (radiation of these regions is concentrated in the interval 200-60 angstrom units and corresponds to color temperature 700,000 - 1,000,000°) and in the regions of the so called condensation (characterised by temperature 1.5-2 million degrees and radiation in the region of 50-10 Å and shorter).

The radiation of the chromosphere and corona is not time-constant - it is subject to more or less intensive variations, both very gradual, connected with the general cycle of the solar activity, and fast in the nature of disturbances. Of special interest are the so called chromospheric flares, developing during a period from several minutes to several tens of minutes and encompassing considerable areas of the surface of the sun, with areal extent upto 10^9 sq.km, which corresponds to about 1/1000 of the solar surface. These flares result in intensification of the chromospheric spectral lines, including the Lyman-alpha lines, and in the intensification of the harder radiation of corona.

Apparently, the radiation boundary of corona during flares reaches 1-2 Å and the color temperature of radiation corresponds to 3 and more millions of degrees.

The absolute values of energy, radiated by the chromosphere and corona, are comparatively low in comparison to energy, radiated by the photosphere of the sun. Thus, the energy flux from the Lyman-alpha hydrogen line at the limits of the earth atmosphere composes about 1 - 10 erg/sq.cm, flux from corona in the region of 100-60 Å composes 0. .1 erg sq.cm/sec, and the radiation flux with wavelength shorter than 10 Å - about 10^{-4} - 10^{-2} erg sq.cm/sec. An essential characteristic of the short-wave radiation is,however,its activity. It ionizes gases, composing earth atmosphere, and is capable of penetrating comparatively deep into the atmospheric stratum. In particular, the lower layer of ionosphere, the so called D layer at an altitude of about 70 km, is specified by the ionizing activity of the Lyman-alpha line. Quick altitude variations of this layer, resulting in disturbance of radio-communication, are, apparently, connected with the appearance of the X-ray radiation shorter than 5-6 Å at the time of flares.

From the above-stated fact the importance of the systematic investigation of the short-wave radiation of the sun is quite clear. The importance is not only to obtain average data. It is of special interest to study its dynamics - time variations, characterizing the non-stationary processes on the sun.

The basic data given above on the short-wave radiation of the sun were obtained by means of devices, set up on geophysical rockets in USA and USSR.

Naturally, the possibility of using for these investigations the satellites permits to extend considerably the limits of investigations and to obtain specially interesting for the science data on temporal variations of spectral composition and intensity of short-wave radiation.

Two types of equipment were set up aboard the spaceship for studying the short-wave radiation of the sun.

In the first type of equipment the receiver of the short-wave radiation was an electronic multiplier of open type with electrodes of activized berillium bronze. In front of the multiplier input was fitted a disc with a set of various filters for the separation of the corresponding spectrum regions of the sun's short-wave radiation. By means of relay-selector mechanism the disc turned after every second at a small angle, setting up in front of electronic multiplier another filter. The following filters were used in the equipment.

1. Coper foil 0.15 mm in thickness for separating spectrum region from 1.4 to 3 Å.

2. Berillium foil 0.06 mm in thickness for separating spectrum region shorter than 12 Å.

3. Aluminium foil 0.005 mm in thickness for separating regions of spectrum from 8 to 20 Å.

4. Polystyrene film with fine carbon coating for separating regions of spectrum from 44 to 100 Å.

5. Lithium fluoride plate 0.5 mm in thickness for separating Lyman-alpha hydrogen line with wavelength 1216 Å.

6. Calcium fluoride plate 0.5 mm in thickness, which considerably attenuates the passing through radiation with wavelength 1216 Å and enables to estimate the background in the area of Lyman-alpha line and thereby to measure more precisely the intensity of the line's radiation.

7. Quartz plate 0.5 mm inthickness for separating radiation with wavelength over 1500 Å.

The last filter is meant mainly for estimating changes in the angle of incidence of the radiation on the filter and receiver, connected with revolutions of the satellite in non-oriented conditions. The equipment had six receivers, set up at various points of the spaceship in a way, that their fields of vision were not overlapping. This made it possible to increase the probability of the solar radiation falling on receivers at any orientation of the spaceship. The sensitivity of receivers is limited in the long-wave region of spectrum. In order to reduce the background from the long-wave radiation of the sun signals from receivers were fed to radio-technical system, the output of which produced voltage, proportional to intensity of radiation falling on the photocathode. Measurement results were transmitted to earth by telemetric system.

The equipment included control block, which ensured cut-in of appropriate receiver, changeover mechanism of filters and other circuits only, when they were litten up by the sun. Moreover there were optical devices to determine the angle of incidence of the radiation on the filters.

The second type of equipment meant for measuring intensity of the soft X-rays of corona in the vicinity of the spectrum edge, mainly during the flares.

Used in this equipment were the most sensitive, for the studied region of spectrum, radiation receivers - photon counters, which are self-quenching Geiger counters with input window of berillium foil, serving as filter. The measurements were conducted in two spectral regions - 10-6 Å and 6-3 Å. To each of these regions of spectrum corresponded six counters, which were grouped into three blocks, containing two counters each at right angle to each other for the first and two counters each for the second region of spectrum. With the photon collided the counter photon, there was a brief electric discharge in the gas filling the counter.

The obtainable current impulses were fed into radio-block, where the signal was amplified and fed into scaling circuit, consisting of triggering cells. This system counted the number of impulses passed during the exposure. The corresponding number in binary arithmetic system was recorded on the autonomous memory device, which stored all the numbers recorded during the 24 hours until their transmission to earth, by telemetric system. The exposure time was 180 seconds, which ensured recording of the solar X-rays with sufficient time resolution.

To protect the inputs of counters from the X-rays emerging with bombardment of the input windows (and surrounding parts of equipment) by high-speed electrons, which are present in the radiation belts of the earth, a system of magnets and diaphragms was provided in front of each of the counters. The magnets deflected to the side all the electrons with energy, not exceeding 15-25 thousand electron-volts. To estimate the background, caused by high-energy electrons, a scintillating counter of electrons was placed on the external shell.

Information obtained by means of described equipment on variations of solar activity in the short-wave region of spectrum will be compared with observations from the earth of ionosphere, visible chromospheric flares and other manifestations, connected with the solar activity. It may be assumed, that in this way correlation will be defined between the processes, taking place in the external envelopes of the sun and earth atmosphere.

The launching and return to earth of the spaceship-satellite, created by the genius of Soviet Scientists, Engineers, Technicians and laborers, is a precursor of a man's flight into interplanetary space.

"Pravda" 4th, 5th, 6th September 1960.

TASS COMMUNIQUE ON THE LAUNCHING OF THE THIRD SOVIET SPACESHIP-SATELLITE:

In accordance with the plan of research work the third spaceship was launched in the Soviet Union on the first day of December 1960 into the orbit of the earth satellite.

In the cabin of spaceship-satellite were placed test animals - dogs Pchelka and Mushka for medico-biological investigations in conditions of space flight. The cabin contained also other animals, insects and plants.

The test animals are observed by means of radio-television equipment and telemetric systems, which transmit to the earth objective physiological indices, characterising the state of the animals.

A number of scientific investigations on the physics of the outer space was envisaged to be conducted by means of the measuring equipment on board the spaceship-satellite.

The third Soviet spaceship-satellite weights without the last stage of carrier-rocket 4563 kg. Its orbit is elliptical. According to preliminary data, the initial orbiting period of the spaceship-satellite is 88.6 min, the perigee and apogee are approximately 187.3 and 265 km respectively. The orbital inclination is 65°.

The spaceship-satellite carries transmitter "Signal", operating on frequency 19.995 mega-cycles per second in conditions of telegraphic sendings of variable duration.

The energy to the board equipment is provided from the chemical and solar current sources. According to preliminary data all the equipments aboard are operating normally.

The ground radio-stations are conducting regular observations of the third Soviet spaceship-satellite.

"Pravda", 2 December 1960.

ABOUT THE FLIGHT OF THE THIRD SOVIET SPACESHIP-SATELLITE:

By 12 hrs Moscow time on the 2nd of December 1960 the third Soviet spaceship-satellite continued orbiting the Globe.

By this time the planned tests of the ship's construction with all the systems aboard, medico-biological investigations, as well as the marked scope of outer space investigations have been fully completed.

Additional data were obtained regarding the effect on the organism of animals, of the various factors, emerging with the entering an orbit by the satellite, and behavior of animals in conditions of space flight. By means of the measuring and television equipment scientific information was obtained on the the functioning of cardio-vascular and respiratory systems of the test animals and their behavior with the effect of vibration, overstrain, noise and weightlessness.

The processing results of information, obtained from aboard the spaceship satellite, show, that the dogs have quite easily endured the period of entering in orbit and the function of their organisms have quickly became normal. The objective physiological indices, characterizing the state of test animals, after many hours in conditions of weightlessness were almost the usual; the behavior of animals was calm, movements coordinated.

Additional data were obtained on reliable construction of the ship, functioning of its individual units and systems, performance of the power sources.

Radio-technical means, meant for controlling of board equipment from the earth and for orbital control, have operated steadily throughout the flight of the spaceship-satellite. TV equipment assured observation of the state and behavior of animals. Transmitted to earth test results have confirmed, that life supporting systems: air conditioning, thermal control and communication operated during the flight quite stably.

The obtained information provided new data for the accomplishment in the near future of a manned-space flight.

On obtaining the necessary data a command was given for the descent of the spaceship-satellite to earth. Due to descent on the non-prescribed trajectory the spaceship-satellite has ceased its existence with the entry into dense atmospheric layers.

The last stage of the carrier-rocket continues its previous orbiting.

"Pravda", 3rd December 1960.

TASS COMMUNIQUE ON THE LAUNCHING OF THE FOURTH SOVIET SPACESHIP-SATELLITE:

In accordance with the plan for investigation of the outer space, on the 9th of March 1961 the fourth spaceship-satellite was inserted into earth orbit in the Soviet Union. The spaceship-satellite weighs without the last stage of the carrier-rocket 4700 kg.

The orbit of the spaceship-satellite was close to prescribed with perigee 183.5 km and apogee 248.8 km. Orbital inclination $64^{\circ}56'$.

The main object of the launching was further improvement in the construction of the spaceship-satellite and of the systems, ensuring necessary conditions for the flight of a man.

The spaceship-satellite carried a cabin with test animal - dog Chernushka and other biological objects, as well as telemetric and TV systems, radio-system for trajectory measurements and radio-communication equipment.

The equipment aboard operated normally during the flight.

After completion of the planned program of investigations the spaceship-satellite the same day accomplished, on command, landing in prescribed area of the Soviet Union.

The preliminary examination of the landed spaceship has shown, that the test animal is quite normal.

As a result of the launching of the fourth spaceship-satellite and its successful descent from the orbit valuable data were obtained both on construction of the spaceship and its systems and on the nature of the flight effect on animals.

At present the obtained data are being studied and processed. Biological objects, which were in flight, are being observed.

"Pravda",10th March 1961.

TASS COMMUNIQUE ON THE LAUNCHING OF THE FIFTH SOVIET SPACESHIP-SATELLITE:

In accordance with the plan for investigation of the outer space a fifth spaceship-satellite was placed into earth orbit in the Soviet Union on the 25 of March 1961.

The main object of the launching is the further improvement of the spaceship construction and the systems, meant for the life support of a man in space flight and return to earth.

The orbit of the spaceship-satellite was almost as calculated, - orbital period 88.42 minutes, perigee 178.1 km, apogee 247 km and orbital inclination 64°54'.

Weight of the spaceship-satellite without the last state of carrier-rocket was 4695 kg.

The spaceship cabin carried test animal - dog Zvezdochka and other biological objects, as well as telemetric and television systems, radio-system for trajectory control and radio-communication equipment.

The equipment of the spaceship functioned normally during the flight.

After implementation of the planned investigations the spaceship satellite was on very same day brought down to earth successfully and landed in prescribed area.

Preliminary examination of the spaceship has shown, that the test animal is quite normal.

As a result of the launching of the fifth Soviet spaceship-satellite and its successful descent from the orbit a great amount was obtained of valuable data both on construction of the spaceship and performance of systems and on the nature of the flight conditions effect on life forms.

At present these data are being studied and processed.

The biological objects, which accomplished the flight, are being kept under observation.

"Pravda",26th March 1961.

THE MAN AND THE OUTER SPACE:

The Soviet science and technique never cease to amaze the mankind by continuously new brilliant successes in the investigation of the outer space. The fifth spaceship-satellite of impressive weight of 4695 kg, carrying in its cabin a quadruped cosmonaut - dog Zvezdochka and other biological objects, took-off on the 25 of March from the territory of the Soviet Union and on the same day on command from earth landed in prescribed area.

The attention of the whole world is riveted to the flights of Soviet spaceships, to the outstanding results, obtained by our scientists in the investigations of the Universe. This interest of the Soviet and universal public is specified primarily by the fact, that each of these flights enriched the science with new important facts regarding the effect of cosmic space conditions on living beings, provides valuable information on performance of the multiple most composite scientific devices, automatics and the spaceship equipment. New data are being accumulated on the unknown depths of the outer space. Finally, we get a clear idea of the growing power of our rocket systems, with unfailing accuracy conveying into outer space progressively heavier spacecrafts.

The flights, accomplished lately, of various living beings and their safe return to earth have another very important, fundamental significance. Each of these flights brings closer the moment, when the passenger of the spaceship will be for the first time a man. This will be a new historical landmark in the development of science.

PROBLEMS OF GREAT IMPORTANCE HAVE BEEN RESOLVED:

Successful launching of spaceships have demonstrated to the world the exceptional possibilities of the Soviet science and technique. An enormous experimental material was obtained, which proves the complete feasibility of a manned-space flight even at present. But the high humaneness of the Soviet science, consciousness of the greatest responsibility for the fate of each man makes it necessary to conduct a series of experimental launchings of spaceship-satellites, in order to be completely confident in the safe flight and return to earth of the first spaceman.

In estimating the possibility of a manned-space flight it is necessary to keep in view two sides of this question - technical and biological.

From the viewpoint of the technical possibilities the flight of a man could be accomplished even today, or to be more precise - could have been accomplished some months back. The weight of the second spaceship-satellite, on which numerous life froms, from the simplest to most composite, have accomplished their flight and safely returned to earth, weighed 4.6 tons. Assuming, that into such a huge spacecraft it would have been possible to place also a man, whose weight would have composed less than two per cent of the spaceship weight. Therefore, from the technical point of view manned-space flight could have been accomplished even in August of last year in the launching of the second spaceship-satellite.

However, this required resolution of many exprementally difficult biological problems. The preparation and accomplishment of flights of various life forms on spaceships and earth satellites, starting from the pioner of space flights the dog Laika, is a continuous series of biological investigations, directed towards resolving precisely this type of problems.

The numerous vertical lifting of animals on rockets, conducted in our country, enabled to accumulate an extensive experimental material on the being of life forms in conditions, similar to space flight. The animals in this case passed a number of tests and returned safely to earth. But bertical take-off, just as the flights along a ballistic trajectory, are not space flights. Many factors inherent to space flights are not inherent to these. The study of these factors and their effect on the life forms is only possible in flights on earth satellites and spaceships.

But this required primarily working out of methods and means for supporting normal life conditions for the inhabitants of the spaceships (preservation of certain composition of the ship's atmosphere, pressure, temperature, providing nurishment for animals, creating sanitary conditions). And at last there followed a series of remarkable biological experiments on spaceship-satellites and on the high-altitude rockets. These have considerably enriched our knowledge of the effect on life forms of flight conditions on rocket ships and enabled to accomplish a new important step in the preparation formanned-space flights. The wide general-biological approach to resolution of the set-up scientific problems, application of bio-telemetry and a great number of other new investigation methods, the use of various biological objects - all this enabled to obtain an extensive and exceptionally valuable material, rich in new interesting facts and conclusions.

The experiments on the spaceships were constructed with an estimate of the most extensive coverage of various biochemical systems and living beings. The applications with this aims were of various ferments, phage, viruses, preparations of cellular nuclei and cytoplasm of cells, bacterial cultures, human and rabbit tissues, fungi (producers of antibiotics), green algae, seeds of highest plants, dogs, mice, rats, guinea pigs and some other organisms. The program included a large number of biochemical, immunological, cyto-logical genetic and physiological investigations.

Due to application of radio-telemetry and television a complete and valuable scientific information was obtained on what changes have occured in the main physiological functions of organisms and how the test animals behaved during various periods of the flight.

As we know, the dogs and other biological objects sent out into space flights, are quite undemanding to environment and can endure without disturbance of physiological functions considerable variations of temperature, humidity and pressure of air, as well as the variations of oxygen content in the air. Nevertheless in the preparation of space flights the problem was to reduce to a minimum the admissible variations of these quantities so as to build-up the most suitable conditions for the existence of life forms in the cabin of the spaceship. The fact is, that appreciable departure of these quantities from normal limits would have placed the animals into conditions of additional physiological strain and would have increased the difficulties of their space flight.

The Soviet scientists managed to provide the required environment in the habitable part of the spaceship, and to obtain information on the changes of these conditions during the flight. Thus, throughout the whole flight of the second spaceship normal air pressure was retained in the cabin with oxygen content from 21 to 24%, humidity - from 37 to 40%, temperature - from +17 to +20°.

Of course, such narrow limits in variations of the main parameters are not required for the animals. However, keeping in view further development of space flights, the problem in these experiments right from the start was to build up conditions most suitable for a human organism.

From the very first or the second of the flight on spaceship the animal's organism is subjected to the effect of various factors, the majority of which so far could not be reproduced in surface and laboratory conditions and which can be investigated only in the conditions of the actual flight.

During the orbital insertion of the spaceship the main affecting factors are the over-strains, connected with sudden velocity acceleration during this period, vibrations and noise.

After the orbital insertion the overstrain is replaced by the state of weightlessness. This lasts right through the orbiting and changes into deceleration overstrain with the entry of the spaceship into dense atmospheric layers.

Finally, throughout the orbiting the animal's organism is subjected to the effect of cosmic radiation, biological action of which requires careful and systematic investigation.

Study of this whole set of problems, which are the main sphere of the new branch of science - cosmic biology, was initiated by the flight of the second Soviet earth satellite, on board of which was the dog Laika. The flight of Laika has shown, that the main danger, connected with prolonged existence of superior-organism animals in the state of weightlessness is unfounded.

FUNDAMENTAL CONTRIBUTION TO SCIENCE:

Later on our scientists had the possibility to use heavy spaceships for an all-round composite investigations of the effect of space flight factors on life forms.

Considerable part of this program was accomplished during the flight of the second spaceship, carrying aboard two dogs - Belka and Strelka, and many other biological objects. In this flight for the first time in history living beings, completing a days flight in the orbit of earth satellite, have been safely returned to earth.

Radio-telemetric and television information from aboard the spaceship was being transmitted troughout the flight. It indicated, that the animals have safely passed period of vibration and overstrain in the active branch of the flight and transition to the state of weightlessness. Even after about an hour and a half after the insertion of spaceship into the orbit of artificial satellite the main indices of the physiological state of the animals (the rate of heart beats, respiration, blood pressure) were found to be almost the same as before the flight. This indicated a quick adaptability of animals to flight in conditions of weightlessness. Further observation of the state of animals also did not show any depatures from the physiological norms.

Telemetric measurements and observations data of animals immediately after landing have shown, that difficulties, connected with the entry of spaceship and landing of capsule with animals have also been successfully overcome. This fact proves, that the methods and means, developed by the Soviet science and technique, ensure maintenance of the necessary life-supporting conditions in prolonged flight and safe return to earth.

The scientific significance of this experiment consists not only in the objective information, which was obtained directly from aboard the ship. The broad program of biological experiment in this flight, just as in the flight of the fourth and fifth spaceships, made it possible to obtain a considerable material, enabling to get an idea of more or less distant consequences of the living beings cosmic flight. This side of the question has an enormous significance for preparing man-in-space flights.

At the present development stage of investigations in the sphere of cosmic biology even a small fact can have an important scientific significance. On the 30th of December last year in the life of the famous now quadruped cosmonaut Strelka has occured an important event - she had a litter of six pups, which at present grow and develop quite well. Strelka has successfully managed bringing up of her numerous progeny, defining in this case all the inherent characteristics of maternal behavior and reflexes for this period.

This circumstance is exceptionally important for the science, as it happens to be a direct proof, that the effect of a complex of very composite factors of cosmic flight on the organism of an animal does not define any adverse consequences in so distant an observation and specially in relation to a function, which, as we know, is the most sensitive, hurt under the effect of cosmic radiation. Naturally, this conclusion pertains only to the concrete duration of the accomplished flight and to a certain orbit, nevertheless with an estimate even of these circumstances it is a fundamental contribution to the still young science - cosmic biology.

FACTS AND CONCLUSIONS:

At present not all the observations of biological objects after their cosmic flight can be considered as complete, however, even the available data show, that the flight factors effect could be different in its trend and biological significance.

Perhaps, the main significance have the numerous and diverse data, indicating on the whole the fact, that the conditions of spaceship flight on the circular orbit below the circumterrestrial radiation belts, do not affect in any appreciable way on the vital activity organisms and not cause any lasting and considerable disorders of their physiological functions.

It is interesting to note, that the dry seeds of some plants (for instance, onion and Nigella), planted after a days flight on the second spaceship-satellite, sprouted much faster than the check plants. In the sprouted seeds the cellular division and growth after flight occured considerably quicker, than in the check plants. The highest acceleration of the growth was observed in ray fungi, interesting to us in connection with the fact, that they produce widely known antibiotics. This kind of observation is, apparently, within the concept of radiostimulation, sufficiently developed in laboratory experiments specially of the last few years.

However, in the investigation of the culture growth of the radiosensitive strain of the ray fungi (8594) its viability (in quantity of survived spores and developed colonies) was found to be 12 times lower, than that of the check culture.

Cytological analysis of material, obtained from the sprouts of some plants (pea, wheat), defined considerable increment in the rate of chromosome reconstructions in the cells of roots and growth points. Similar, although less defined changes were marked in divisible cells of bone narrow in mice.

Thus, as a result of carried out investigations the presence of the effects of cosmic flight factors different in trend and bilogical significance on viability and hereditary properties of various animal and plant objects were discovered.

In the preparation of prolonged flights undoubtedly of interest are the investigations of the natural immunity dynamics of animals in cosmic flight. The primary data on this question available at our disposal indicate the presence of changes in the state of immunological blood activity in dogs after the flight, in particular of the rise of its fagocytic function, i.e., their capacity to pathogenic agents.

Enormous significance in the program implementation of space investigations has the flight of the fourth Soviet spaceship. The biological problem of this experiment was the investigation of continued effect of the space-flight conditions on the state of life forms, effectivity and reliability determination of the life support systems. The available data indicate, that the performance of these systems was effective and steady during all the periods of the flight.

A wide range of biological objects (dog, mice, guinea pigs, insects, etc.), participating in this flight, will enable our investigators this time also to cover considerable sphere of the questions, having an exceptionally important scientific and practical significance.

The experimental material of this flight is still being processed and analysed. The obtained data will substantially supplement and enlarge our ideas regarding the effect of space flight factors on various aspects of the organisms viability.

All these data are of considerable interest in the respect, that they were obtained in the actual conditions of the primary cosmic radiation, particle composition and energy of which differ considerably from the composition and energy of particles in the radiation, being used by the scientists in the usual laboratory investigations.

It should be mentioned, that data obtained on the remote consequences of the space flight cannot be at present regarded with sufficient accuracy as the effect of any one concrete factor. Apparently, they should be regarded as the effect of the whole space flight. In the task of further investigations the need should, apparently, be taken into account of differential investigation of the biological significance of each of the cosmic flight factors - overstrain, vibrations, weightlessness. This work is being continued at present.

REALISTIC PROSPECTS:

The experiments on spaceships have enabled also to:

- determine and prove the effectivity of a great number of systems, providing for life support on the ship;
- investigate effects of the flight factors on a complex of physiological and biological indices;
- test methods of investigations and to select biological objects, most fully answering to resolution of corresponding theoretical and practical problems.

The problem of providing safety for a manned-space flight of short duration is resolved more simply, than for a long duration. Prolonged manned-space flights, specially the inter-planetary travel, set to biology considerably more complex problems, than those mentioned above. Thus, provision of the required gas medium in hermetic cabin of a spaceship for short-duration flights could be done by means of high-activity chemical substances, separating oxygen with absorbtion of water vapours and carbon dioxide, exhaled by animals. But for the long-duration flights and in the interplanetary flying the creation is required of a complete ecological medium within an enclosed space. It is well known, that the main requirements for creating this medium were outlined by K.E. Tsiolkovskii. Primarily in this the requirement should be kept in view of creating habitual for the man on earth environment, air regeneration, in which the biological methods will play an important role, elucidation of methods for disposing of the human organism excrement, i.e., development of all the conditions, which would have ensured comforts of earth life on the spaceship with the use of those facilities, which are provided to us by the outer space.

Therefore, the preparation of prolonged cosmic flights requires working out of new approaches, principles and means for assuring normal viability, work and rest of the crew of the spaceship. The way to this is being supplied by the nature itself of our planet.

Most probably, the inevitable companions of a man in future space flights, as well as to other planets, will be the green plants. On earth precisely these compose the conditions, necessary for the life of man and animals, purify the air from carbon dioxide. The absorb the carbon dioxide and produce the vitally necessary oxygen during the photosynthesis process. This performance is carried out by surface plants and even more so by the finest water plants numerous in their mass and exceptionally quickly propagating.

The necessity to provide the future spacemen by a full-value food ration will, probably, require inclusion into life support system, besides the green plants, also animals, using plants as food and coverting them into more complete animal products, required for the man's nurishment. It can be imagined, that at some stage it may be found expedient to use the vital activity products of the animals by means of bacteria and the same green plants, just as it occurs in the surrounding us nature.

Thus, the means for the main life support of the future interplanetary flight crews could be represented as the closed system of the biological cycle of matter, where there is no need for a great reserve of food and where all that is required for a man is being obtained by the green plants with the use of the energy of solar rays, carbon dioxide and water of the spaceship cabin's atmosphere.

In this connection grandiose problems are facing our physiologists, microbiologists, biochemists, biophysicists, geneticians. On the whole it is difficult to find a sphere of biological knowledge, contribution of which is not of significance in the development of a complex of questions, composing now the subject of cosmic biology, An important place in these investigations will take up the study of the monocellular microscopic green algae - chlorella, this unique factory of oxygen, which, apparently, will be a valuable companion of spaceman in prolonged voyages.

The accomplishment of a manned-space flight will open other great possibility for science. For many years now the scientists discuss the problem of life in the outer space. On the basis of indirect data various hypotheses were put forward, the checking of which requires direct proofs. It is difficult therefore, to draw a final conclusion on the possibility and forms of life on the other planets. Now the study of these questions is becoming experimental. The biological science, thereby, gets an actual possibility to study the life problems in the outer space.

In its significance and possible consequences this problem acquires fundamental importance. As the formulation itself, so is the approach to resolving the problem of life in the outer space became possible due to successes in chemistry, physics, mathematics, nuclear technique, radio-technique, electronics. In its turn the elucidation of the regularities of life, knowledge of the nature of vital processes enrich these sciences, placing in front of them new, sometimes unusual problems. In this - one of the typical specifics of interaction of sciences in the modern natural science.

Truly limitless will be the possibilities of man, who accomplishes entry into infinite space of the Universe. In truth inestimable is the role of cosmic biology in providing this possibility to the man. There is no doubt, that the Soviet Scientists will not spare themselves for making real this gradiose problem.

N. Susakyan, academician.

"Pravda", 26, 27 March 1961.

CHAPTER - V

MANNED SPACECRAFT FLIGHTS

TASS COMMUNIQUE ON THE FIRST IN THE WORLD MANNED SPACE FLIGHT

The first in the world spaceship-satellite "Vostok" with a man on board was placed into earth orbit in the Soviet Union on the 12 of April 1961.

The pilot of the spaceship satellite "Vostok" was the citizen of the Union of Soviet Socialist Republics flight-major Gagarin Vurii Alekseevich.

The take off of the multistage rocket was successful, and after picking up orbital velocity and separation from the last stage of the carrier-rocket the spaceship-satellite began its free flight in the earths orbit.

According to preliminary data the orbital period of the spaceship-satellite is 89.1 minutes; perigee - 175 km, apogee 302 km; orbital inclination $65^{o}4'$.

The weight of spaceship-satellite with pilot-cosmonaut is 4725 kg. without the weight of the last stage of carrier-rocket.

A two-way radio-communication has been fixed and is maintained with comrade Gagarin - the cosmonaut. Frequency of the short-wave transmitters aboard are 9.019 and 20.006 megacycles per second. The condition of the cosmonaut in flight is being observed by telemetric and television systems.

The period of entering into the orbit of the spaceship satellite "Vostok" has been satisfactorily borne by comrade Gagarin, who is feeling quite well at present. The life support system aboard the spaceship is functioning normally.

The manned orbital flight of the spaceship satellite "Vostok" is containing.

Biography of the Hero.

Major Yurii Gagarin, the first in history pilot-cosmonaut is 27 years old. He was born on the 9th of March 1934 in Ghhatskii area of Smolenskii region

(Russian Federation) in the family of a collective-farm worker.

In 1941 he entered middle school, but the invasion of Hitler's army has put a stop to his education.

After the end of the second World War the Gagarin family have shifted to Gzhatsk town. There Yurii continued to study in middle school. In 1951 he finished with distinction trade school in Lyubrtsy near Moscow in profession of smelter-moulder and simultaneously the school of working youth.

Thereafter Yurii Gagarin studied in the technical school in Saratov on Volga. In 1955 he finished the technical school with distinction.

His start in aviation Gagarin began while still a student of the technical school. He learnt in

Since 1957, when Gagarin finished the flying school in first division, he is serving as a flier of Soviet aviation.

Last year Yurii Gagarin has joined the ranks of the Communist Party of the Soviet Union.

He is married. His wife Valentina Gagarina, 26 years old, has finished medical school in Orenburg. Their daughter Elena is two years old. The second daughter Galya is one month old. Gagarin's Father - 59 years old Aleksei Ivanovich - is a carpenter. His mother, Anna Timofeevna born in 1903, is a housewife.

"Pravda" 13 April 1961.

Yu.A.GAGARIN'S STATEMENT BEFORE THE TAKEOFF.

Yu. A. Gagarin before the flight on spaceship-satellite "Vostok" made the following statement to the press and radio.

Dear friends, near ones and unknown, countrymen, peoples of all countries and continents!

After a few minutes the powerful spaceship will carry me away into distant space of the universe, what can I say to you during these last minutes before the takeoff? My whole life seems to me now as one beautiful moment. All, that was lived through, that was done before, everything was lived and done for this minute. You can yourselves understand, how difficult it is to sort out one's feelings now, when so near is the hour of test, for which we were getting ready long and passionately. There is no need to speak of my feelings, when this first in history flight was offered to me. It was not only joy. It was not only pride. It was great hapiness. To be the first in space, to be alone in unprecedented combat with nature - can one dream of anything greater?

But immediately thereafter I thought of the collosal responsibility, placed on me. To accomplish first the thing dreamt of by the generations of people, to pave the way for humanity into the outer space ... Name me a more complex problem, than the one fallen to me. This responsibility is not to one, not to tens of people, not to the collective. This is a responsibility to the whole Soviet people, to the mankind, to its present and future. And if nevertheless I'am determined on this flight, it is only because I'am a communist, because I have behind me examples of unequaled heroism of my countrymen - Soviet people. I know, that I shall gather all my will power for the best carrying out of the assignment. Realizing the responsibility of the problem I shall do everything in my power to carry out the assignment of the Communist Party and Soviet people.

Am I happy, departing into space flight? Of course, I'am happy. The greatest hapiness of people at all times and epochs was to participate in new discoveries.

I would like to dedicate this first space flight to the people of communism - society, into which our Soviet people have already entered and into which, I am sure, will enter all the people on earth.

Now only the count minutes remain before the takeoff. I tell you good-bye, dear friends as people tell each other, when departing on a long journey. How I wish I could embrace you all, friends and strangers, distant and near ones!

"Pravda", 18 April 1961.

TASS COMMUNIQUE ON THE FLIGHT OF SPACESHIP "VOSTOK"

9 hrs. 52 minutes.

According to the data, received from aboard the spaceship "Vostok", at 9 hrs 52 minutes. Moscow time pilot-cosmonaut Major Gagarin, being above South America, has transmitted: "The flight is normal, I feel well".

10 hrs 15 min.

At 10 hours 15 minutes Moscow time pilot-cosmonaut Major Gagarin, flying above Africa, transmitted from aboard the spaceship "Vostok": "The flight is normal, the state of weightlessness does not bother me".

10 hours 25 minutes

At 10 hours 25 minutes Moscow time, after orbiting the Globe in accordance with prescribed program, the brake rocket was switched, and the spaceship satellite with the pilot-cosmonaut Major Gagarin began its descent from the orbit for landing in the preset area of the Soviet Union.

"Pravda", 13 April 1961.

ON SUCCESSFUL RETURN OF A MAN FROM THE FIRST SPACE FLIGHT.

After a successful carrying out of the planned investigations and implementing the flight program Soviet spaceship "Vostok" accomplished on the 12 of April 1961 at 10 hours 55 minutes, Moscow time a safe landing in a prescribed area of the Soviet Union.

Major Gagarin, the flier-cosmonaut communicated:"Request to inform the Party and the Government, that the landing was normal, I feel well, no injuries and bruises".

The accomplishment of manned space flight opens out a great prospects in the conquering of the space by mankind.

"Pravda", 13 April 1961.

TO COMMUNIST PARTY AND THE PEOPLES OF THE SOVIET UNION! TO PEOPLES AND GOVERNMENTS OF ALL COUNTRIES! TO THE WHOLE PROGRESSIVE MANKIND!

The address of the Central Committee of the CPSU, Presidium of the Supreme Council of USSR and the Government of the Soviet Union.

A great event has taken place. For the first time in history a man has accomplished a flight into space.

On the 12 of April 1961 at 9 hours 7 minutes Moscow time spaceship satellite "Vostok" tookoff with a man on board into space and after completing a flight around the Globe, has safely returned to the sacred land of our Motherland - the Country of the Soviets.

The first man to penetrate into space is a Soviet man, citizen of the Union of Soviet Socialist Republics!

This is an unparalleled victory of a man over the forces of nature, the greatest achievement of science and technique, triumph of human reason. The man-in-space flight has been initiated.

This feat, which will be recorded for ever, embodies the genius of the Soviet people, mighty power of socialism.

With a feeling of great joy and justified pride the Central Committee of the Communist Party, Presidium of the Supreme Council of the USSR and the Soviet Government record, that this new era in progressive development of mankind have ushered in our country - the country of victorious socialism.

In the past the backward tsarist Russia could not even dream of accomplishing such feats in the fight for progress, of competing with countries more developed in technical and economical respect.

By the will of the working class, the will of the people, inspired by the party of communists with Lenin at the head, our country became transformed into mighty socialist power, attained unprecedented heights in the development of science and technique.

When the working class in October 1917 took the power into its hands many, even honorable people, doubted whether it can govern the country, to retain even the achieved level in the development of economy, science and technique.

And now in front of the whole world the working class, Soviet collective-farms peasantry, Soviet intelligentsia, the whole Soviet people demonstrate the unprecedented victory of science and technique. Our country has outstripped all other

States in the world and is the first to pave the way into the outer space.

The Soviet Union was the first to launch an inter-continental ballistic missile, the first to send out an artificial earth satellite, the first to execute a moon shot, created the first artificial satellite of the sun, accomplished venus probe. One after another the Soviet spaceships satellites with living beings on board flew into the outer space and returned to earth.

The crown of our victories in the mastering of space is the triumphal flight of the Soviet man on a spaceship around the earth.

Honor and glory to the working class, Soviet peasantry, Soviet intelligentsia, to the whole Soviet people!

Honor and glory to Soviet scientists, engineers and technicians - creators of the spaceship!

Honor and glory to the first cosmonaut - comrade Gagarin Yurii Alekseevich - pioner in the mastering of the space!

To us, the Soviet people, who are building communism, the honor has fallen of being the first to penetrate into space. Victories in conquering of space we consider not only the achievement of our people, but of the whole mankind. We gladly place them at the service of all the nations, in the name of progress, happiness and good of all the peoples on the earth. Our achievements and discoveries we place to the service of peace and well-being of people, and not to the service of war.

Development of science and technique opens out new possibilities of mastering the forces of nature, using them for the good of a man, but for this the peace has to be ensured first.

On this great day we once again appeal to nations and Governments of all the countries for peace.

Let all the people, irrespective of race and nation, color, religion and social order, apply all power to ensure a stable peace in the world. Let us put an end to the race for armament! Let us accomplish general and total disarmament under a strict International control! This will be the decisive contribution to the sacred cause of protecting peace.

The glorious victory of our Motherland inspires all the Soviet people to new heroic deeds in the building of communism!

Forward, to new victories in the name of peace, progress and happiness of humanity!

Central Committee of the CPSU.

Presidium of the Supreme Council of USSR

Council of Ministers, USSR

Moscow, Kremlin, 12 April 1961.

"Pravda", 13 April 1961.

GLORY TO THE SOVIET SCIENTISTS, DESIGNERS, ENGINEERS, TECHNICIANS AND WORKERS - CONQUERORS OF THE OUTER SPACE!

To all the scientists, engineers, technicians, workers, all collectives and organisations, participating in the successful accomplishment of the first manned space flight in the world on the spaceship-satellite "Vostok".

To the first Soviet cosmonaut comrade Gagarin Yurii Alekseevich.

Dear comrades!

Friends-compatriots!

The glad, exciting event is being experienced by the peoples of our country. On the 12 of April 1961 for the first time in the history of mankind our Motherland - the Union of the Soviet Socialist Republics - has successfully accomplished a manned space flight on the spaceship-satellite "Vostok".

The Soviet manned space flight is the greatest achievement of the creative genius of our people, result of the free and inspired labor of the Soviet people - builders of communism. That, of which in the past dreamed outstanding representatives of the Russian and world science and technique, to which Konstantin Eduardovich Tsiolkovskii, the genius of our people, have dedicated his life, has become a living reality of our heroic days. This is a great outstanding contribution of the Soviet people into the treasury of the world science and culture. This inestimable great service of the Soviet Union will be gratefully welcomed by the mankind. The heroic flight of the Soviet man into the outer space has opened a new era in the history of the earth. The centuries-old dream of mankind has been fulfilled.

The Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of USSR and the Council of Ministers USSR in the name of our glorious Communist Party, Soviet Government, all the Peoples of the Soviet Union heartily congratulate the the great victory of reason and labor all scientists, designers, engineers, technicians, workers, all groups and organisations, participating in successful accomplishment of the first manned space flight in the world.

We heartily greet and congratulate You, our dear Yurii Alekseevich Gagarin, with the greatest feat - first flight into space.

Our free, talented and hard-working people, raised by the Party of communists headed by the great Leader and Teacher of workers of the world Vladimir Il'ich Lenin in October 1917 to conscious historical creation, shows today to the whole world the greatest advantages of the new, socialist order in every sphere of the life of society.

The manned space flight is a result of successful implementation of a grandiose program of the large-scale communist building, of unfailing care of the Communist Party and its Lenin's Central Committee and the Soviet Government of continuous development of science, technology, culture, of the good of the Soviet people.

There is an inter of less than four years between the launching of the first in the world Soviet artificial earth satellite and the successful manned space flight.

Soviet scientists, engineers, technicians, workers by their persistent and selfless labor opened the way for a human genius into the depths of the universe. And they have done it in the name of peace on earth, in the name of happiness of all the peoples.

The first manned space flight will become the source of new inspiration and daring for all the Soviet people in the name of further progress and peace in the whole world.

Glory to the Soviet scientists, designers, engineers, technicians and workers - vanquishers of the outer space!

Glory to our people - creator-people, conqueror-people, who pave the way under the leadership of the Communist Party to a bright future of the all mankind - communism!

Long live the glorious Communist Party of the Soviet Union - great inspirer and organiser of all the victories of the Soviet poeple!

Long live communism!

Central Committee of CPSU	Presidium of the Supreme Council of USSR	Council of Ministers USSR

"Pravda", 13 April 1961.

DECREE OF THE PRESIDIUM OF THE SUPREME COUNCIL OF USSR FOR CONFERRING THE TITLE OF THE SOVIET UNION TO THE FIRST IN THE WORLD SOVIET PILOT-COSMONAUT MAJOR Yu.A. GAGARIN.

For the heroic deed - first flight into space, which brought glory to our socialist Motherland, for courage, valor, fearless and selfless serice to Soviet people, the cause of communism, the cause of progress of the whole mankind to confer title of the Hero of the Soviet Union with investment of the order of Lenin and "Golden Star" medal to first in the world pilot-cosmonaut Major Gagarin Yurii Alekseevich and to put up a bronze bust of the Hero in Moscow.

Chairman of the Presidium of the Supreme Council USSR

L. Brezhnev

Secretary of the presidium of the Supreme Council USSR

M. Georgadze.

Moscow, Kremlin, 14 April 1961.

DECREE OF THE PRESIDIUM OF THE SUPREME COUNCIL OF USSR FOR CONFERRING THE TITLE OF THE "PILOT-COSMONAUT OF USSR" ON FLIGHT MAJOR GAGARIN Iu.A.

For accomplishing the first in the world space flight on spaceship satellite "Vostok" to confer the title of "Pilot-Cosmonaut USSR" on the citizen of the Soviet Union Flight Major Gagarin Yurii Alekseevich.

Chairman of the Presidium of the Supreme Council USSR

L. Brezhnev

Secretary Presidium of the Supreme Council USSR.

M. Georgadze

Moscow, Kremlin, 14 april 1961.

"Pravda", [illegible] [illegible] 1961.

IN THE CENTRAL COMMITTEE OF THE CPSU
AND THE COUNCIL OF MINISTERS USSR.

The Central Committee of the CPSU and the Council of Ministers USSR have recognised as necessary to confer orders and medals of USSR on scientists, workers, technicians, engineers, participants in construction of spaceship satellite "Vostok" and the first in the world successful flight of Soviet man into space. Appropriate ministries and departments were entrusted to confer the awards on the personal staff of participants in construction and launching of the spaceship satellite "Vostok".

"Pravda", 16 April 1961.

UNPRECEDENTED VOYAGE TO THE STARS.

Press-conference in the Scientists Club.

The Academy of Sciences USSR and the Ministry of Foreign Affairs USSR have arranged yesterday in the Scientists Club a press-conference, dealing with the successful accomplishment of the first in the world space flight of a Soviet man on the spaceship satellite "Vostok".

Invited to the press-conference were the representatives of the Soviet and foreign press diplomats, members of the Presidium of the Academy of Sciences USSR, well-known scientists, representatives of Public Organisations of Moscow. There were about a thousand people gathered at this memorable press-conference.

Tumultous ovation greeted the appearance in the hall of the renowned son of the Soviet people, first Pilot-cosmonaut Yurii Alekseevich Gagarin.

The press-conference was inaugurated by A.N.Nesmeyanov, President of the Academy of Sciences USSR.

Address of A.N. Nesmeyanov.

On the 12 of April 1961 for the first time in history spaceship-satellite "Vostok" with pilot-cosmonaut Yu.A.Gagarin was placed into earth orbit.

This was in the morning. The spaceship entered an orbit with perigee 175 km and apogee 302 km. The orbital period was 89.1 minutes. The weight of spaceship with the cosmonaut composed 4725 kg.

The spaceship was equipped with everything necessary for the safe flight of the cosmonaut and its safe landing. Many systems of the spaceship were doubled. There were devices aboard, which enabled the pilot to determine at any time his orbital position.

A two-way radio-communication was continuously maintained with the pilot, both at the takeoff and during the flight.

We must emphasize the courage, endurance and self-control of Yu.A. Gagarin. The night before the flight, as advised by the doctors, Gagarin slept soundly and was awakened some hours before the flight. His pulse was steady throughout the preparations and after the takeoff of the rocket. He jocked and by his cheerful mood made more certain the assurance of the flight's success.

When he was informed, that command is being given for the start of rocket engines, he merrily exclaimed: "Well, let's go!".

During the orbital insertion of the ship, when the powerful rocket engines were operating and the cosmonaut was experiencing the effect of the overstrain, vibrations and noise, even during this tense moment of the flight the cosmonaut Gagarin continuously transmitted everything necessary not only of his feelings, but also about the performance of the cabin's systems. After the passage through the dense atmospheric layers, when the cosmonaut saw the earth, he transmitted:"How beautiful it is!".

[illegible] about the flight Yurii Alekseevich [illegible] continuous communication with the earth. At 9 hours 52 minutes, flying above South America he informed: "The flight is normal, I feel well". At 10 hours 15 minutes, flying above Africa, Yurii Lekseevich transmitted: "The state of weightlessness does not bother me".

At 10 hours 25 minutes the brake rocket of the spaceship was switched, and the spaceship with the pilot-cosmonaut began descending from the orbit for the landing in prescribed area. At 10 hours 55 minutes the Soviet spaceship "Vostok" accomplished a safe landing.

Thus, having been accomplished the greatest feat, a new brilliant page is written in the history of civilization of the mankind. This is a heroic feat of the Soviet people, guided by our own Communist Party and the Soviet Government. This is a feat of large groups of scientists, designers, engineers, technicians and workers, this is a feat of all the testers, who assured faultless preperation and lauching of the spaceship, a feat of all the services, who provided for normal flight and landing of the spaceship, this is a heroic feat of the daring son of the Soviet Fatherland - Yurii Alekseevich Gagarin. His name is even now a legend.

Everything in this feat is symbolic: that the first cosmonaut is a Soviet man, and that the first spaceship, aboard which Yurii Alekseevich has accomplished the flight is named "Vostok", and also the fact, that the flight was accomplished in the morning. And this morning has become the morning of a new era.

Hence for ever the day of the 12 April 1961 will be linked with the feat, accomplished by Yurii Alekseevich Gagarin. The whole flight around the earth was completed in 108 minutes, and these minutes shook the world.

The culture of mankind has a long fantastically amazing history. Every feat, whereas its the creation of the first letters or construction of the first steam engines, or the first round-the-world voyage, - all these are dates, when the mankind went up a new step, confirming the power of progress and creation. These feats were not always recognized immediately, there was a fierce struggle of the old with the new, and the more revolutionary was the event, which opened the way into future, the more acutely resisted the past.

On the threshold of the 20th century, the unrecognized genius Tsiolkovskii has for the first time shown mankind the way to the stars. In his work was laid the foundation of the scientific principles of cosmonautic - science, one of the brilliant triumphs of which we are marking today.

The words of Constantin Eduardovich Tsiolkovskii: "The earth is the cradle of reason, but one cannot live forever in the cradle", have come true.

Yurii Alekseevich Gagarin, the first pilot-cosmonaut, have passed through a long and strenuous preparation. This was unusual system of training, intensely scientific, which provided the cosmonaut with the necessary technical knowledge, connected with the construction of the spaceship and its systems, knowledge in astronomy, geophysics, biology and other sciences.

The pilot-cosmonaut passed tests of overstrain on special centrifuge machines, on vibration benches. For days an weeks lasted the tests in closed cabins in full imitation of space cabins. The landing system was being tested. All this enormous labor was completed by the first space flight in history.

Dear Yurii Alekseevich!

In the name of the Presidium of the Academy of Sciences USSR I greet you, a remarkable Soviet man, Columbus of the outer space.

Centuries will pass, but your name will forever remind the people of the greatest feat, which was accomplished by the Soviet scientists, designers and you personally, by accomplishing the first manned space flight. You have shown to the whole mankind an example of courage, daring and heroism in the name of the service to humanity!

A.N. Nesmeyanov, academician, Letter to Yu.A. Gagarin the gold Tsiolkovskii medal, with which the Presidium of the Academy of Sciences USSR rewarded the hero for accomplishing the first in the world space flight aboard a spaceship-satellite "Vostok".

Address of Yu.A. Gagarin.

Dear comrades, esteemed guests!

Many are interested in my biography. As I was reading in the newspaper, some frivolous people in the United States of America, distant relatives of the princes Gagarin, seem to think, that I'am some relative of theirs. But I can disappoint them. Their behavior was irresponsible. I'am a common Soviet man. I was born on the 9 of March 1934 in a family of collective-farm peasant. My birth place is Smolenskii region, Gzhatskii district. Among my relatives there are no princes or noble people. My parents prior to revolution were poor peasants. My gradfather was also a poor peasant and there were no princes whatsoever among us. I'am sorry for these "noble" relatives, but they will have to be disappointed.

I have studied in the trade school in Lyubetsy of Moscow region, then entered Saratov technical school on profession of smelter-moulder. But for a long time my dream was to become a flier, I had a wish to fly. On completion of technical school in 1955 I at the same time completed a flying course of the Aeroclub aeroclub, and thereafter was admitted into Orenburg school of aviation, which I have finished in 1957 and became a fighter-pilot. I served in one of the divisions of the Armed Forces of Soviet Union.

At my earnest request I was made one of the candidates for cosmonauts. I have passed the selection and, as you can see, became a cosmonaut. I have undergone an appropriate training, the program of which was worked out by our scientists and which was described in detail by the President of the Academy of Sciences. I have well studied the technique and was ready for the space flight.

I'am very happy, immesurably grateful to our party, our government for thrusting me with this flight. I accomplished it for the sake of our motherland, for the sake of the whole heroic Soviet people, for the sake of Communist Party of the Soviet Union and its Lenin's Central Committee.

Before the flight I felt very well, excellently, was full of confidence in successful outcome of this flight. The technique is very good, very reliable, and I, and all my friends, scientists, engineers and technicians were in no doubt about the success of this flight.

During the flight I also felt excellent.

During the insertion period, the effect of over-strain, vibration and other tensions were not too depressive on my state and enabled me to work efficiently, according to the program, prescribed for the flight.

After the orbital insertion, after separation from the carrier-rocket weightlessness has appeared. Initially this feeling was somewhat strange, although even previously, before this, I experienced a brief effect of weightlessness. But I soon got used to this condition and continued to carry out the program, assigned to me for the flight. In my subjective opinion, weightlessness does not affect the efficiency of the organism, on the implementation of physiological functions.

Throughout the flight I worked efficiently according to the program. Took my food, water, maintained radio-communication with the earth on several channels, both on telephone and on telegraph. I watched the performance of the equipments of ship made reports to earth and made entries into the journal and on tape-recorder. I felt perfectly well throughout the period of weightlessness, the efficiency was fully retained. Thereafter in accordance with the flight program the command was given for descent. The brake rocket was switched on and the velocity became as required for the descent of the spaceship to earth. The landing was in accordance with the program and I was happy to meet on the earth our dear Soviet people. The landing was in the prescribed area. I would like to tell you a little about the observations, which I conducted while in the space.

From this altitude - 175-300 km - the earth is clearly seen. The view of earth surface is approximately the same, as can be observed during a flight at high altitude on a jet plane. Very distinct are the large mountain masses, big rivers, large forest masses, shore line, island. Clouds covering the earth surface and their shadows on the surface are very clearly visible. The sky is absolutely black. The stars against this sky look brighter and more clearly visible. The earth has a very characteristic, very beautiful pale blue aureol. This aureol is very clearly seen, when one observes the horizon, smooth transition from the azure, blue, violet and absolutely black color of the sky. Very beautiful transition.

With coming out from the shadow the sun got in and was shining through the earth's atmosphere. And here this aureol of slightly different color. On the surface, right at the horizon it was possible to observe a brightly-orange color, which thereafter changed into all the colors of the rainbow: to azure, blue, violet and black color of the sky.

The entry into the earth's shadow is very quick. At once there is darkness and nothing can be seen. I could not

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observe anything now in the surface, nothing was seen, as, apparantly I was passing above an ocean. If there were big cities I shoul have seen the lights.

The stars are clearly observed. The exit from the earth's shadow is also very quick.

Since I was fully prepared, the space flight factors did not affect me very much. Now I feel excellent.

I'am very grateful to our designers, engineers and technicians, to the whole Soviet working people, who constructed this marvelous spaceship "Vostok", its marvelous equipment, powerful carrier-rocket, which permits orbital insertion of such enormous spaceships.

I'am immeasurably glad, that my beloved country was the first in the history of mankind to penetrate into the outer space. The first plane, the first satellite, first spaceship and the first man-in-space flight - those are the stages on the way of my motherland to master the nature's secrets. Toward this object our people are being led by Lenin's Communist Party.

At each step of my education, life and work - in trade school, in technical school, in aeroclub, in aviation school - I felt constant care and attention of the party, of which I'am a member and a son. I particularly wish to mention the loving human care, which is shown in the Soviet Union to common people by the Central Committee of the party and the Soviet Government.

We dedicate our flight to heroic Soviet people, our government, beloved Communist Party and to XXII convention of the Communist Party.

We propose to fly a lot with assurance and to conquer the outer space in a proper way. We are always glad of the achievements in the development of science in other countrics, glad to welcome in space cosmonauts of other countries. We wish them success in the peaceful mastering of the space and would like to cooperate with them in the peaceful use of the space.

I, personally would like to fly a lot into space. I begun to like it. I want to fly to venus, mars, to fly regularly.

Address of N.M. Sisakyan, academician.

The man has always strived to investigate and conquer the celestial space. This idea lies at the basis of folk lore, legends and daring dreams. One of these, born in the Greek mythology, narrates about how ivarus, son of Daedalus, went up into the air on wings, attached by wax. He rushed toward the sun, but, when he came near it, his wings disintegrated. The Icarus has fallen to the earth. The bold and daring dream continued to excite the creative genius of a man and to serve as a source for the search of new ways to conquer the universe.

Aerostats, planes, rockets and artificial earth satellites went up into the air ocean. Man has acquired wings, fixed by the strongest alloy - science laws. They not only made it possible for a man to strengthen himself on the earth, but also to open the way into space.

To-day we are marking an event of historical significance - first in the world manned space flight. In this connection special mention deserves development of methods for selection and training of spacemen. The spaceman is a new profession, coming into being for the first time in history. Combined in the person of the Soviet spaceman are the bravery of Aleksander Matrosov, valor of Jalil, stability of Zoya Kosmodem'yanskaya, iron will-power, raised by the great Lenin's party.

The spaceman was raised as such by our Soviet reality, the science equipped him with the necessary knowledge, ability to overcome the difficulties of the flight. Selection of persons, suitable in health for space flights, and their scientifically based special preparation and training are the new problems. In their working out the scientists proceeded from the estimate of the space flight peculiarities, results of numerous preceding experiments in biology, knowledge of the conditions of being and activity of a man in space cabin, and also from those reactions, which could be expected from the spacemen in flight. Naturally, the spaceman could be only an absolutely healthy man, with high level of intellectual development and technical knowledge, a man of strong will power, capable during emergency without loss of time to make a required resolution and immediately carry it out, to be able to estimate conditions quickly and accurately.

The selection system of spacemen provided for a thorough examination in stationary conditions of clinic. In selection of candidates for space flight there was additional use of special methods of investigation, which permit to determine quite fully functional possibilities of the man's organism, his adaptability to effects adverse factors of the external medium. These tests were conducted on centrifuges, vibration stands, in heat chambers, pressure chambers, in conditions of prolonged isolation and restricted movement is in surdo-chambers - arrangements excluding penetration of external stimulants (sound, light, etc.).

The importance in selection of spacemen was the psychological investigations. During the preparation and training there were more detailed investigations, required for the final decision whether the spaceman should be admitted for the flight.

The preparation consisted in the study of theoretical questions, connected with the problems of the forthcoming flight and also acquiring by the spaceman of practical habit in using the equipment of space cabin, research instruments, etc.

The spaceman has acquired a deep knowledge on many special questions, connected with the flight dynamics of rocket ships, space physics, effect of the flight factors on a man's organism. It is quite obvious, that great significance in the preparation for the flight had physical development of the spaceman.

Physical training was purposeful. Methods and means were used as in the usual exercises and sport. In order to perfect all the physical qualities, which are specially necessary for a man in space flight, the emphasis was put on enhancing the stability of organism to the effect of accelerations, working out and perfecting the habit of free body control in space, subtle coordinated movements. The capacity was enhanced of the spaceman to endure prolonged physical strain without reduction in efficiency, will power qualities made stronger.

Moreover, an important place was taken by a special system of training, the main task of which was to familiarize the spaceman with conditions, expected in flight, in other words, in laboratory conditions on earth or in flights on planes to imitate as fully as possible the specifications of the space flight.

This part in the preparations of the spaceman was, perhaps, the most important and at the same time the most difficult.

Thus, the preparation of the spaceman for the space flight is a composite scientific problem. However, in spite of all its complexity and unusual difficulty, it, as we can see, has been successfully resolved.

Today with great joy and pride we congratulate our dear countryman, the first in the world spaceman Yurii Alekseevich Gagarin, who performed an unprecedented feat. This feat has a universally-historic significance.

It was prepared by a collective heroism of our scientists, laborers, engineers and technicians, selfless labor of our people under the leadership of the Communist Party of the Soviet Union.

Thus, the way into space is open. An enormous work has been done and a great victory has been won. In front of our science open out new, extremely wide prospects: the man should not only penetrate, but to consolidate himself and to master the universe.

Address of V.V. Parin.

To prepare a man for the first space flight required considerable strain of the creative powers of a large group of medicos, physiologists, biologists, psychologists.

The manned space flight was preceded by enormous work of launching the first Soviet satellites, inhabited with animals: dogs, small animals and other biological objects. In this historical experiments not only extremely important scientific data were obtained on the effect of space flight factors on life forms, but a system was perfected of scientific medical control. These investigations enabled to select the most reliable and effective methods for investigating and recording physiological functions, and the main thing is, to construct systems for a safe flight and return of the spaceship to earth.

Scientists have devised a special equipment for continuous automatic control of physiologically important parameters of environment and functional reactions of organism. This equipment, as we know, has passed a successful test in preceding space flights on spaceships satellites.

Thus, the medico-biological provision was prepared for the forthcoming manned space flight.

And even then the problem of the collective, which prepared o spaceman, was difficult and had no precedent in the past. However with all its complexity it was considerably simplified by the remarkable work of the spaceman himself, who became a true scientific worker and coauthor in the joint work with many scientists. A separate and special problem presented working out of methods for an objective control of the man's state. The scientists have managed to develop a single system for physiological functions control, specially of respiration, blood-circulation, both during the pre-takeoff period and during the flight.

Special problem was the preparation of a man during the pre-takeoff period. Intensified medical control, special food, regular examinations in surface conditions by methods, meant for the flight - all this assured singularity and continuity in obtaining the most valuable information, and made it possible also to obtain the starting data for further analysis of the reactions of human organism in space flight.

Investigations of the biocurrents of the brain, muscles, detailed electrocardiography, vectocardiography and many other things assured the required volume and depth of the necessary health control of the spaceman during the pre-takeoff period. At the same time there was constant medical and psychological observation, biochemical and immunological tests, checking the emotional and nervous state of the cosmonaut.

Throughout the flight of Yurii Alekseevich Gagarin his state was continuously checked medically. Besides the communications on his feeling, which he periodically transmitted by radio, doctors and physiologists observed by means of radiotelemetry the pulse and respiration of the first man in space.

A lot of experience, acquired by the telemetry - new trend of science combining the latest achievements of medicine and electronics, was placed on the 12 of April 1961 at the service of humanity. It is difficult to overestimate the significance of objective biotelemetric data in ensuring the safety of outstanding flight. Mounted within the space suit of cosmonaut were simple and convenient sensors, transforming physiological parameters - biological heart currents, pulse variations of the vascular wall, respiratory movements of the chest into electric signals. Special amplifying and measuring systems provided for the issue to radio-channels of impulses, characterising respiration and blood-circulation during every stage of the flight.

Preliminary data, obtained in processing of radiotelemetric information, show, that from the medical point of view, the flight of Yurii Gagarin was extremely good. Pulse and respiration variations during the acceleration and descent were approximately the same, as during the numerous training. In conditions of weightlessness the pulse and respiration were almost comaletely normal.

Thus, the first experiment of applying biotelemetry for medical checking during the manned space flight was extremely successful. This shows, that the work of our scientists in this sphere is conducted along the correct lines with expectation of new successes.

In conclusion it may be said, that the space flight first in the history has produced extremely valuable data on the man's state in space, confirmed the forecast of Soviet scientists not only of the possibility of a man-in-space flight, but also of the possible retainance by a man of his creative power and various efficiency.

Great is the role in this of the scientists and workers, great and heroic is the role of the remarkable Soviet man Yurii Gagarin, his friends, his wife and relatives.

Address of E.K. Fedorov on the International significance of the first man-in-space flight.

The matter dealt with here is only the first information on the flight of comrade Gagarin. The appropriate reports and other scientific data will be published later.

All of us present here will for ever remember this meeting with the first spaceman Yurii Alekseevich Gagarin.

The world is full of admiration for his courage and expresses deep respect for his skill, for his excellent management of the so far unknown difficult problem of the first space flight.

Yu. A. Gagarin was alone beyond the earth's atmosphere, but his feat reflected the enormous labor of a great number of workers, engineers, scientists, who constructed the spaceship and made its flight possible.

When the first Soviet earth satellite entered an orbit, some people in other countries, perhaps even some of the correspondents of western countries present here assumed, that this is the result of single isolated sucess of the Soviet Union. Now nobody thinks that. During the short period since the flight of the first satellite till today, it became clear to every one, that the successes of the Soviet Union in space are the regular stage in the science and technique development of a socialist country.

Central Committee of the CPSU, Presidium of the Supreme Council USSR and the Council of Ministers USSR in their address emphasized, that the Soviet people consider victories in space as not only their achievement, but the achievement of the whole mankind.

"We gladly place them at the service of all the nations, in the name of progress, happiness and good of all the people on earth. Our achievements and discoveries we place at the service not of war, but at the service of peace and safety of nations".

You will recall, that the entry of the first artificial earth satellite into orbit did not induce the Soviet Union to declare its special right in the space. The appearance of the Soviet pennant on the Moon did not result in allotment of some lunar territories to the Soviet Union.

Our scientists report the result obtained by them at numerous international conferences, discuss them with their colleagues from all the countries of the world. Even now a group of Soviet scientists with academician Blagonravov participates in the scientific conference of International Commission on space investigation, participants of which rejoice jointly with us in the new great victory of human genius.

And this first manned space flight the Soviet people also contribute to the treasury of the scientific achievements of the whole mankind.

Today's rate of the scientific and technical progress is amazing, but it should be kept in view, that further on it will increase.

Yu. A. Gagarin has flown around the Globe in 108 minutes. The thoughts of scientists are directed to further space flights, to investigations of the moon and planets, toward penetration into concealed mysteries of the structure of matter, toward the fundamentals of the life processes. And at the same time we can see distinctly all the disorders, disarrangement on our earth. It is not a disgrace for the mankind, that in some areas of our planet people are still starving. This is a reproach to those, who ravaged and pitilessly exploited, and in some places even now exploiting countries which are backward in their development.

While flying above Africa, comrade Gagarin saw Congo, where quite recently Lumumba, heroic fighter for the happiness of Congolese people, was villainously murdered.

Soviet scientists know, that this state of affairs on the earth worries the progressive scientists, all progressive people throughout the world. Development of science and technique opens out limitless possibilities for the mastering of nature's forces, and our duty, our common care is to use them for the good of man. This needs primarily to ensure peace.

Now, when a new victory is being marked of the human genius, we, the Soviet scientists, ask all of you, press representatives, and specially the representatives of Western press to bring to the conscience of your readers., to the conscience of all the people on earth the solemn appeal of the Communist Party of the Soviet Union and Soviet Government to the whole world. The appeal for the people, irrespective of race and nation, color of skin, religion and social affiliation, to apply all their power to ensure a lasting peace. The realistic and quick way for lasting peace is known since long - this is a general and total disarmament under a strict international control. Resolution of this main problem would have enabled the peoples of the world to apply their forces to space investigations, and to other affairs worthy of man.

"Pravda", 16 April 1961.

FIRST MANNED SPACE FLIGHT

On the 12 of April 1961 in the Soviet Union has been accomplished first manned space flight. The spaceship "Vostok" with pilot-cosmonaut of USSR Yu. A. Gagarin on board was launched into the orbit of the earth satellite. Weight of the spaceship-satellite without the last stage of the carrier-rocket was 4725 kg. Perigee distance, according to confirmed data, obtained by the processing of all the measurements, was 181 km, apogee - 327 km, orbital inclination $64^{\circ}57'$.

On completion of orbital flight, the spaceship satellite has safely landed in prescribed area of our country.

The first space flight of a Soviet man opens the era of direct penetration of a man into space, one of the most outstanding events in the history of civilization. The accomplishment of this flight is a result of extensive single-minded program of work on the mastering of the outer space, conducted in the Soviet Union.

The great dream is coming true of the initiator of space flights K.E. Tsiolkovskii! The mankind will not remain eternally on the earth, in pursuit of light and space, but will first timidly penetrate beyond the atmosphere, thereafter will conquer for himself the whole of the circumsolar space".

Decisive step in the mastering of space.

For many millennia the inquisitive mind of a man strived to penetrate the depths of the universe. This is the indestructible need of a man for knowledge, striving to find his place in the universe, to learn to control the laws of nature.

The modern science has at its disposal an enormous store of means for space study. Distances, which are even now attainable for these means, are expressed in astronomic figures.

The outer space is a world of stars, stellar clusters galaxies, among which is our solar system. The advanced science, armed with the science of dialectic materialism, asserts the existance of numerous worlds, in which the development is possible of the highest matter life. The beginning of life in the universe is a phenomenon in no way exceptional. It cannot be concretely asserted, where, besides our solar system, life exists at present and in what form, but it does exist.

With the appearance of a man on the earth begun a qualitatively new stage of the earth's development as a planet. Coming to know the laws of nature, the man begun changing the earth arming himself with the powerful means in the fight with nature. From the first stone chopper the man came to accomplishment of the greatest feat - first space flight.

By space flights the man penetrates directly into a new to him region. And any penetration into a new region involves new discoveries, which often it is impossible to foresee before. Thus, it is only the flights of the first satellites permitted to detect the radiation belts of the earth, which changed considerably our concept of the circum-terrestrial space and radiation danger in space flights.

At present it is difficult to estimate fully all the significance of the space flights and the possibilities, which it opens. One thing is undoubtful - penetration of a man into the outer space will immeasurably extend the limits of our knowledge, will enrich the science and culture.

In our time the development rate of the science and technique increases with every year. Today we are witnessing successes, which it was impossible to imagine only 15-20 years ago. Undoubtedly, further development of science and technique and, in particular, the technique of space flights will be progressing more rapidly.

Even in the nearest future the use should be expected of the space vehicles for resolving a number of practical problems. Weather service and ice survey, retranslation of TV and radio transmissions, implementation of the most extensive scientific investigations extra-atmosphere of earth will be only the first steps on this path. They will be followed by the flights of man to the moon and other planets of the solar system, construction of inhabited interplanetary stations, gradual mastering by a man of life in space. And in the distant future - seeming now fantastic possibility of establishing communication with other worlds.

Among the enormous number of scientific and technical problems, which faced Soviet scientists and designers in the preparation and accomplishment of the first manned space flight, one of the main problems was to provide the necessary conditions for a safe flight of the man and his return to earth. For resolving this problem a great number was required of design work and experimental takeoffs.

In examining the possible versions of the first manned flight it was recognized as expedient to accomplish it on a spaceship-satellite, since this flight directly opens out the way into space for a man. The ballistic trajectory flight on a rocket, which is actually not a space flight and is mainly for the sake of senstation, has been discarded. Therefore the fact is not accidental, that the Soviet scientists and designers directed their efforts right from the start for construction of satellites and spaceships of big size and weight. This was the principal line of the space flight development in the USSR. Only in this way was it possible to resolve the historic problem of a manned space flight.

Starting from the second Soviet earth satellite, aboard which was the under-test animal the dog Laika, upto the spaceship satellite "Vostok" the Soviet scientists and designers have unfailingly followed this way.

It was necessary to obtain the information as much as possible on construction performance of the spaceships, their equipment, to perfect reliable control of various systems during the flight. The principally new problem was the construction of the orientation systems of the spaceships satellites and the problem of the spaceships return to earth.

For a manned flight it was necessary to provide aboard the spaceship maintenance of normal pressure, temperature, air composition and other life support conditions of a man.

Scientific space investigations side-by-side with resolving the main problems on the space physics have provided the necessary data on the effect of various radiations on life forms in conditions of space flight, and also on the meteoric danger in flight. On basis of obtained data measures were taken for radiation protection of the spaceships.

A considerable experimental material, obtained as a result of the first flights of the Soviet spaceship satellites, and construction of systems, providing for the safe return of the spaceships to earth, enabled the Soviet scientists and designers to begin construction of a ship for a manned space flight. As a result of intensive work spaceship "Vostok" has been constructed. In March 1961 two last check launchings were carried out. During these takeoffs a mannequin was placed into the pilot's armchair. Moreover there were test animals in the cabin - dogs Chernushka and Zvezdochka.

The flights were carried out according to the same program, as was planned for the first manned space flight. Both the flights were in exact correspondence to preset program and confirmed the high reliability of construction and all the systems aboard the ship.

Thorough preliminary working of the spaceship-satellite "Vostok" assured complete success in its very first launching with the spaceman aboard, implemented on the 12 of April, 1961.

Construction of the spaceship "Vostok".

The spaceship "Vostok" was constructed on the basis of experiences, obtained with the launching of the first Soviet spaceships-satellites.

The spaceship-satellite consists of two main sections:

- pilot's cabin, which contains the spaceman, life support system and landing equipment;

- instrument compartment, meant for the equipment, operating during the orbiting and the brake rocket of the spaceship.

After entering an orbit the spaceship separates from the last stage of the carrier rocket. During the flight the equipment aboard operates in accordance with a certain program, providing the measurements of the orbital parameters, transmission to earth of telemetric information and TV picture of the spaceman, two-way radio-communication with the earth, maintenance aboard the ship of preset temperature, air-conditioning in the pilot's cabin. The equipment is controlled automatically, by means of programing devices on board and in case of need by the pilot-cosmonaut.

The program of the first manned space flight was designed for one orbital period. However the construction and equipment of the spaceship-satellite make possible a longer flight.

Fig. 1. Flight diagram of spaceship-satellite"Vostok"

1. orbital entry, 2. switch in of brake rocket;

3. descent.

On completion of the flight program, prior to landing, special system orients the spaceship in a certain direction. Then at a prescribed orbital point the brake rocket is switched which decelerates the velocity of spaceship to prescribed one. As a result the spaceship changes › descent trajectory.

The cabin with the spaceman gets decelerated in the atmosphere. The descent trajectory is selected so, that the overstrain with the entry of the vehicle into dense atmospheric layers would not exceed that, tolerable for a man. After the descent of the space cabin to preset altitude the landing equipment is switched. Direct landing of the pilot's cabin is at low speed. From the moment the brake rocket is switched till the landing the spaceship flies for about 8000 km. Duration of flight during the period of descent is about 30 min.

The external surface of the pilot's cabin is coated with a layer of heat insulating material, which protects it from burning during the descent in the dense atmospheric layers. In the shell of the cabin are three illuminators and two fast-opening hatches. The illuminators have heatproof glasses and enable the cosmonaut to conduct observations throughout the flight.

The spaceman is in the ejector seat, which is his working place during the flight, and also serves as a means of escape in case of need. The seat is arranged in such a way, that the overstrain during take off and descent would be on the chest and back of the spaceman.

In the first flight the pilot-cosmonaut was wearing a space suit, designed to protect his life and efficiency, even in the case of the cabin's dehermetization during the flight.

The spaceship satellite carried also the following:

- life support systems (air-conditioning, pressure-regulation, food and water, elimination system of vital activity products);
- flight control and manual control systems;
- landing system;
- radio-equipment for the contact of spaceman with earth;
- independent recording system of data on performance of instruments and systems and various sensors;
- TV system for observing the spaceman from the earth;
- physiological functions recorder;
- brake rocket;
- orientation system;
- flight control equipment;
- radio-systems for measuring orbital parameters;
- thermal control system;
- power supply sources.

On the external surface of the spaceship are the control members, orientation elements, shutters of the thermal control system and radio antennas.

The pilot's cabin on the spaceship-satellite is more spacious than the pilot's cabin aboard an airliner. The cabin's equipment is designed for working convenience of the spaceman during the flight. From his seat the spaceman is able to conduct all the operations on observation, communication with earth, flight control and in the case of need - to control the spaceship.

The following are mounted on the pilot's seat:

- separable back with harness for fixing the pilot's body in ejection and descent on parachute;
- parachute systems;
- ejection and pyrotechnical equipment;
- emergency rations and radio-set for communication and radio bearing, which the spaceman can use after landing;
- ventilation system of the space suit and parachute oxygen device;
- the seat automatics.

The landing of the spaceman could be in the cabin. This method of landing was checked on the fourth and fifth Soviet spaceships-satellites, on which the cabin contained the test animals. Landing by ejection of seat with the pilot from the cabin at altitude of about 7 km and subsequent landing on parachute was also provided for. This version was also checked in the launching of spaceships-satellites.

The conditioning system on the spaceship maintains in the pilot's cabin normal pressure, normal concentration of oxygen with concentration of carbon dioxide not over 1%, temperature at a level of 15-22°C and relative humidity within 30-70%. Air regeneration - absorbtion of carbon dioxide and water vapors with emanation of corresponding amount of oxygen - is implemented by means of highly-active chemical compounds. With reduction of oxygen and increment of carbon dioxide special sensor gives a signal, at which the operating mechanism changes the working conditions of regenerator. With excessive emanation of oxygen the operating mechanism operates automatically, resulting in reduced emanation of oxygen into the cabin's atmosphere. The air humidity is regulated in the same way.

In the case of air contamination by harmful admixtures, as a result of the vital activity of the human organism and operation of devices, special filters are provided for its purification.

Maintenance of the preset temperature conditions of the spaceship during the flight is implemented by the thermal regulation system. The distinction of the system is the use of liquid cooling agent for the removal of heat from the pilot's cabin. The temperature of the agent is always maintained stable. It is fed from the thermal control system into the air-water radiator. Air consumption through radiator is controlled automatically, depending on the temperature in discharging apparatus. Thus, the preset temperature conditions are maintained in the cabin with high precision.

To maintain the stable temperature of the cooling agent and providing the required temperature conditions in the instrument compartment there is a radiation heat exchanger on its surface with a shutter system, which is also controlled automatically.

For descent into prescribed area, a fully-determined orientation should be imparted to the spaceship prior to switching in the brake motor. This problem is resolved by the orientation system. In the given flight the orientation to the sun was of one of the ships axes. The sensitive elements of this system is a number of optical and gyroscopic sensors. Their signals are converted in electronic blocks into commands, controlling the system of control members. The orientation system automatically finds the sun, gives a corresponding turn to the ship and maintains it in required position with high accuracy.

After the spaceship is oriented, the braking motor is switched in at a certain moment. The commands for the switch in of orientation system, brake motor and other systems are issued by the elec· :ic programming device.

For the orbital parameters measurements of the spaceship and performance control of its equipment it carries radio-measuring and radio-telemetric equipment. The orbital parameters measuring and reception of telemetric information during the ship's flight are conducted by the ground stations on the territory of USSR. Measurements data are automatically transmitted along communication lines in computing centers, where these are processed by the electronic computers. As a result information is quickly obtained during the flight regarding the main orbital parameters and further movement of the ship is forecast.

The spaceship carries also a radio-set "Signal", operating on frequency 19.995 megacycles persecond. This set is for the radio bearing of spaceship and partial transmission of telemetric information.

The TV system transmits the picture of the spaceman to earth, which makes possible visual checking of his condition. One of the TV cameras transmits a picture of the spaceman in face, the other - in profile.

The two-way communication of the spaceman with the earth is provided by radio-telephone system, operating in short-wave band (9.019 and 20.006 megacycles per second) and ultrashort waveband (143.625 megacycles).

The ultrashort wave channel is used for communication with ground stations at distances upto 1500-2000 km. The short-wave channel communication with ground stations on the USSR territory could be assured, as experience has shown, in the greater part of orbit.

The radio-telephone system includes a tape-recorder, enabling to record the spaceman's speach during the flight with subsequent reproduction and transmission during the flight of the spaceship above the ground reception stations. The possibility was also provided of radio-telephone transmission by the spaceman.

The instrument panel and the control board of the pilot, set up in the cabin,are meant for controlling operation of the main systems and for descent of the ship in the case of need by manual control. Arranged on the instrument panel is a number of needle indicators and signal charts, electric clock and a globe, revolution of which is synchronized with the orbiting of the spaceship. The globe enables the spaceman to determine the current position of the spaceship. On the pilot's control board are the handles and switches for the control of radio-telephone system, temperature regulation in the cabin, and also for switching in the manual control and brake motor.

Special attention in construction of the spaceship was paid to the safety of the flight. Launchings of the first Soviet spaceships satellites confirmed the highly reliable performances of their systems and equipment. However on the spaceship "Vostok" a number of additional measures were taken to eliminate the possibility of any accidents and to ensure the safety of a man in flight. This trend of development is fully conversant with the main problem - to construct vehicles, which permit a man to penetrate safely into the outer space.

For the orientation of spaceship in the case of manual control the spaceman uses an optical orientator, which permits to determine the position of the spaceship in relation to earth. The optical orienter is set up on one of the illuminators in the pilot's cabin. It consists of two circular mirror-reflectors, light filter and glass with net. The rays, coming from the horizontal line, fall onto the first reflector, and hence through the glasses of illuminator pass onto the second reflector, which directs them through the glass with net into the eye of the pilot. With correct orientation of the ship in respect of the vertical the spaceman can see in the vision field the image of horizon in the shape of a ring.

Through the central section of the illuminator the spaceman surveys section of the earth surface, lying below him.

The position of the longitudinal axis of the spaceship in relation to the flight's direction is determined by observing "running" of the earth surface in the vision field of the orienter.

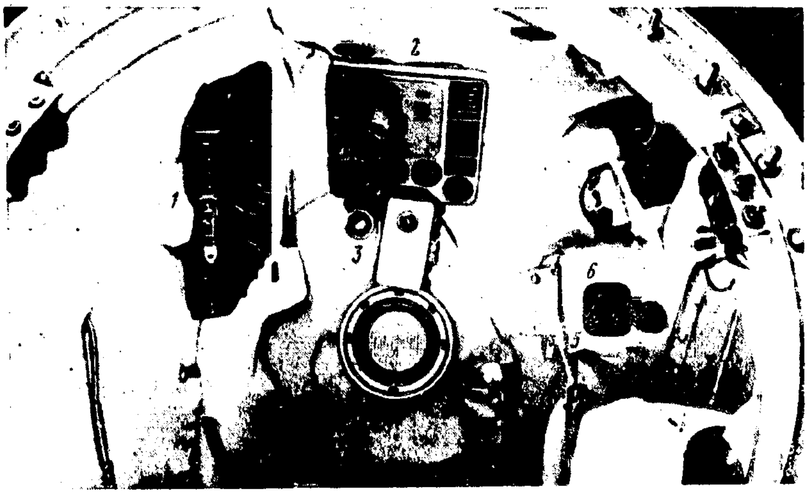

Fig. 2. The inside view of the pilot's cabin on spaceship-satellite "Vostok".

1. pilot's control board, 2. instrument panel with globe, 3. TV camera, 4. illuminator with optical orienter; 5. handle for orientation control of spaceship; 6. radio-receiver, 7. food container.

By using the controls the spaceman can swing the spaceship so, that the line of horizon would be seen in the orienter as a concentric ring, and the direction of the earth surface "race" would coincide with the course line of the grid. This will indicate correct orientation of the spaceship. In the case of need the vision field of the orienter can be covered by light filter or shutter.

The globe on the instrument panel makes it possible to determine besides the current position of the spaceship also the point of its descent by switching the brake motor at a certain moment.

Finally, the construction of the ship makes it possible to descend to earth also in the case of failure of the brake motor - by natural braking in the atmosphere.

The reserves of food, water, regeneration substances and capacity of power sources are estimated for a 10 days flight.

Care has been taken in the construction of the spaceship to prevent rise of temperature in the cabin above a certain limit with prolonged heating of its surface during the gradual braking of the ship in the atmosphere.

Medico-biological aspects of the man-in-space flight

To resolve the question of a man's possible flight into the outer space and his medical provision, the following seemed necessary:

1. To study the effect of factors of space flight on the organism and also to investigate the possible form and means of protection against the adverse effect of these factors.

2. To work out the most effective methods for providing normal conditions of life support for a man in a space cabin.

3. To devise methods for medical selection and training of the spaceship crews, and also a system of continuous medical checking of the health state and efficiency of pilots at every period of the flight.

Each of the listed problems included a number of individual problems, the study and resolution of which was the constant task during the last ten years of specialists in physiology, hygiene, psychology, biology, clinical and professional medicine. The investigations were made in ground laboratories and during the flight of animals on the rockets. Experience has been used, accumulated in applied spheres of physiology and medicine, specially in aviation medicine and medical provision of submarines. Where ever it was possible ground stands were constructed, which enabled to investigate in laboratory conditions the effect on organism of factors, active in space flight. The effect of overstrains and their endurability by the organism were studied on centrifuges. They reproduced accelerations, similar to those during the launching of the spaceships or their return to earth.

By means of vibration stands, heat and vacuum chambers and other installations the effect of other factors was investigated. However the laboratory tests, as a rule, could give an answer only in relation to the effect of any one of the indicated factors on organism, whereas in the actual rocket flight their effect is combined and simultaneous. Moreover in laboratory conditions the behavior of life forms could not be studied under the conditions of weightlessness. Therefore the nearest approach to studying effect of space flight on the organism were the biological investigations on rockets, which began in 1951.

Scores of experiments were carried out with rocket flights of animals to altitudes upto 450 km. As a result of these investigations an extensive scientific material was obtained, characterising reactions of physiological systems and behavior of animals (dogs, rabbits, rats and mice) at various periods of the flight. Careful investigation of the test animals both during the flight and for a long time after their return to earth made it possible to come to conclusion, that conditions of rocket flights into the upper atmospheric layers are quite satisfactorily endured by life forms. Changes, marked in individual physiological functions during the flight, were not of morbid nature, frequently disappeared even during the experiment and were not detected thereafter.

However, due to the briefness of the rocket flight, it was not possible to investigate the biological effect of such important space flight factors, as prolonged weightlessness and cosmic radiation. Therefore the possibility, provided in 1957, to use for biological experiments artificial earth satellites was an exceptionally important step forward.

The first of these experiments was conducted on the second Soviet earth satellite. It not only confirmed and extended data of the previous biological tests on the rockets. For the first time it was possible to prove, that the prolonged state of weightlessness itself does not disturb the main processes of vital activity.

Biological experiments were continued on the first Soviet spaceships-satellites. The program of these medico-biological investigations included a number of new problems.

It seemed important, besides the additional and more detailed study of the effect on organism of prolonged weightlessness, transitions from weightlessness to over-strain and vice-versa, to investigate as thoroughly as possible the biological effect of cosmic radiation. An important section of the program was the investigation of the operation and effectivity of systems for normal life support of man in future flights and his safe return to earth. For implementation of the planned program the first Soviet spaceships satellites carried aboard various representative of the organic world, from the lowest life forms to the highest vertebrates.

The use in experiments of various animal and plant species enabled to study specially fully and in detail the effect of space flight on most diverse processes and functions of organisms. Very extensive was the information on behavior and physiological functions of the test dogs during the flight. The animals behavior was observed by means of a special TV system. The analysis of obtained data has shown, that the animals not only fully retained their vital activity in conditions of prolonged weightlessness and subsequent overstrain, but there are no morbid indications whatsoever in their main physiological functions. A long and careful examination of the animals after the flight did not define any departures from normal.

A very serious attention was paid to detecting possible effects of cosmic radiation. Multiple methods, used for resolving this question, did not define changes, which could have been attributed to ionizing radiation.

The results of medico-biological investigations on spaceship-satellites enabled to draw a most important conclusion. It was recognised, that spaceship flight along an orbit below circumterrestrial radiation belts are safe for highly-organised specimen of animal world. Results of biological experiments were used fore resolving the question on possible endurance of flight conditions by a man.

On the basis of this, and also taking into account results of laboratory investigations, the conclusion of the possible flight for a man without any harm to his health was drawn.

Preparation of spacemen.

The first space flight could be accomplished only by a man, who, recognising the enormous responsibility of the problem facing him, consciously and voluntarily agreed to give all his power and knowledge, and perhaps even life, for the accomplishment of this outstanding feat. Thousands of Soviet citizens - patriots of their motherland, of most diverse ages and professions, have expressed their desire to accomplish the space flight. Soviet scientists were faced with the problem of scientifically founded selection of the first spacemen from the huge number of desirous persons.

In space flight the man encounters effect of a whole complex of external factors (acceleration, weightlessness, etc.), considerable nervous and emotional tension, requiring of a man mobilization of all his moral and physical faculties. Moreover the spaceman has to retain high efficiency, ability to orient himself in the composite environment of the flight and in the case of necessity to take over the spaceship control. All this determined high demands to the health of the spaceman, his psychic qualities, level of his general and technical preparation.

These qualities are most fully combined in the flyer's profession. The activity of the flyer already determines the stability of the nervous and emotional sphere of the man, his high will power, and this is specially important for the first space flights. In future category of persons, taking part in these flights, undoubtedly should and could be considerably extended.

In the setting up of a group of spacemen conversations were conducted with a great number of pilots, wishing to accomplish the space flight. The most prepared of them passed a thorough clinical and psychological examination. The aim of this examination was to determine the state of health, define latent deficiency or low stability of the organism to individual factors, typical of the forthcoming flight, to estimate the reactions of a man under the effect of these factors.

The examination was conducted with the use of a number of modern biochemical, physiological, electrophysiological and psychological methods and special functional tests, enabling to estimate the reserves of the main physiological systems of the organism (investigation in pressure chamber with considerable rarefaction of the air, with barometric pressure differential and oxygen breathing at high pressure, centrifuge investigations, etc.).

The important stage was the psychological investigation, directed toward defining persons with the best memory, quick thinking, active easily-switching attention, capacity for quick acquiring of exact coordinated movements.

As a result of clinico-physiological examination a group was formed, which began implementation of a special education program, training on special stands and training apparatus, imitating in surface and flying conditions factors of the space flight. Simultaneously determination was made of individual reactions of organism to effect of the imitated factors.

The program of special education were designed for acquiring by the spacemen of required information on the main theoretical questions, connected with the problems of the forthcomin flight, and also practical experience in the use of equipment and instruments in the space cabin. This program provided for the study of principles of the rocket and space technique, construction of spaceship, special questions on astronomy, geophysics, fundamentals of space medicine.

The set of special trainings and tests included:

- flights on planes in conditions of weightlessness;
- training in a model of a space cabin on special training apparatus;
- prolon ed staying in a specially equipped sound-proof chamber;
- training on centrifuge;
- parachute jumps from planes.

During the special training some questions of a manned space flight, in particular those connected with the nourishment of the spaceman in flight, his clothes, air-regeneration system were resolved.

During the plane flights individual reac ions of the spacemen with the effect of weightlessness and transition from weightlessness to overstrains were observed. The possibility was studied of maintaining radio-communication, taking water and food, etc. This enabled to answer a number of important questions on possible actions of a man in conditions of space flight.

It was established, that all the selected spacemen endure quite well the state of weightlessness. Moreover, it was shown, that under the conditions of weightlessness lasting upto 40 sec. it is quite possible to take fluid, semifluid and solid food, implementation of fine coordinating acts (writing, purposeful movements of hand), maintenance of radio-communication, reading, as well as visual orientation in space.

Training in the model of a space cabin and on the special training apparatus was conducted in order to study the equipment and instruments of the cabin, performing versions of the flight's assignment, adaptation to being in the real space cabin. Constructed for this purpose was a special training apparatus-stand, which by means of electronic imitators made it possible to reproduce changes, corresponding to those in the flight. The actions of the pilot corresponded to the real ones. There were imitations of emergency flights and training of spacemen in actions, to be taken in a situation like that.

The main object of investigations during the long confinement in the specially equipped sound-proof chamber was determination of the nervous and psychological stability of the spaceman during its prolonged confinement in isolated space of limited dimensions, in solitude with no external stimulants. In this case the time-table of the day and meals were arranged similar to those, which would exist in the real flight.

The great sphere of physiological investigations, as well as the special psycho-physiological methods enabled to define people with best indices in accuracy, clear implementation of assignments, having a more stable emotionally-nervous sphere.

In the training on centrifuge, in heat chamber the determination was made of individual endurance [illegible] of corresponding effects, their influence was studied on the course of the main physiological functions, questions were decided of enhancing stability of organism to the factors of external medium. As a result of investigation it was fixed, that the spacemen possess high stability against the above factors, persons were defined, who withstood the tests better than others.

During the parachute training each spaceman accomplished some scores of jumps. The physical training of the spacemen group was composed of [illegible] training [illegible] exercises. The planned training was conducted taking into consideration the individual characteristics in the physical development of each spaceman. The morning exercises were conducted daily for an hour with the object of general physical preparation. The physical training was directed to enhaning the stability of organism against the effect of accelerations, developing and perfecting habit of free control of the body in space, enhancing the capacity to withstand prolonged physical strain.

The physical training was conducted under a constant medical supervision and combined specially selected gymnastic exercises, games, diving, swimming and exercises on special apparatus.

On completion of the special training program direct preparation was organised to the forthcoming space flight. This included:

- study of flight assignments, landing area maps piloting instructions, maintenance of radio-communication, etc.;
- study of emergency rations, their use in locality after landing, study of radio bearing system, etc.;
- tests on centrifuge in space suit at the peak of expected overstrain;

- prolonged tests in the model of space cabin with the use of all the life support systems.

As a result of the education and training work a group of spacemen ready for space flight was selected.

Flight-Major Yu. A. Gagarin was selected from the group of spacemen for the first in the world manned space flight.

A remarkable Soviet man Yu. A. Gagarin was born on the 9 of March 1934 in the family of collective-farm worker. His dream since long was to become a pilot. Having finished in 1957 the Orenburg aviation school and obtained a licence of fighter-pilot, Yu.A. Gagarin served in one of the sections of the Armed Forces of the Soviet Union. At his insistant request he was included as one o the candidates for spacemen and passes successfully the selection. In the preparation of the group of the spacemen Yu. A. Gagarin was one of the best.

Yu. A. Gagarin has fully justified the high trust to be the first in the world pilot-cosmonaut.

The first space flight.

The spaceship "Vostok" tookoff on the 12 of April 1961 at 9 hours 07 minutes Moscow time.

Throughout the whole period of launching the pilot-cosmonaut Yu. A. Gagarin continued radio-telephone communication with the control center of the flight. During this period the spaceman felt perfectly well. He clearly fixed variations of the overstrain and the separation moments of the carrier-rocket stages. The noise in the space cabin was not above the noise in the cabin of a jet plane. Even during the period of launching Yu.A. Gagarin could observe the earth in the illuminators.

Control of the ship's equipment, orientation and descent was automatic. However, in the case of emergency, the spaceman at his own wish or on command from the earth can take-over the control of the spaceship, determine its position and land in a selected area.

The weightlessness was felt when the space-ship entered into the orbit. At first this state was strange to the spaceman, but soon he became used to it. Throughout the whole weightlessness period Yu. A. Gagarin felt quite well, his efficiency was fully retained.

In accordance with the assignment and the flight program he watched the performance of the ship's equipment, maintained continuous communication by radio telephone and telegraph with the earth, conducted observations through illuminator and optical orientator, made reports to earth and recorded the data of the observations into log book and tape-recorder, took his meals and water.

The earth's surface was clearly visible from altitudes upto 300 km. Shore lines, big rivers, surface relief, forest masses, clouds and shadows from clouds were clearly defined. While flying above the territory of our country Yu. A. Gagarin saw masses of farm fields.

The sky was absolutely black. The stars were brighter and more clearly visible, than from the earth. The earth has a beautiful azure halo. The colors at the horizon vary from pale-azure, through azure, blue, violet-to the black color of the sky. On coming out from the shadow a bright-orange color could be observed at the earth's horizon, which thereafter changed into all the colors of the rainbow.

The automatic orientation system was switched at 9 hours 51 minutes. After the exit from shadow the system searched for and oriented the ship on the sun.

At 9 hours 52 minutes Yu. A. Gagarin, flying in the area of Cape Horn, transmitted one of the messages about feeling well and about the normal performance of the equipment.

At 10 hours 15 minutes the automatic programming device issued command for the preparation of equipment for switching on brake motor. At this moment the spaceship was approaching Africa and routine message was received from Yu. A. Gagarin on the course of the flight.

At 10 hours 25 minutes the brake motor was switched on and the spaceship changed its path from the orbit earth satellite to the descent trajectory.

At 10 hours 35 minutes spaceship began its entry into the dense atmospheric layers.

Having completed the first in the world space flight with a cosmonaut on board, the spaceship-satellite "Vostok" landed in prescribed area at 10 hours 55 minutes Moscow time.

After his return from space flight Yu. A. Gagarin feels very well. No disorders were detected in his health state.

The first in the history of mankind space flight, accomplished by Soviet cosmonaut Yu.A. Gagarin on a spaceship satellite "Vostok", enabled to draw conclusion of enormous scientific significance about the practical possibility of a man-in-space flights. It has shown, that a man can normally endure the conditions of space flight, orbital entry and return to the earth surface. This flight has proved, that in conditions of weightlessness a man fully retains his efficiency, movement coordination, clearness of thinking.

The flight has provided extremely valuable data on the construction and equipment performance of the spaceship in flight. The correctness of scientific and technical decisions, on which its construction was founded, was fully confirmed.

also confirmed was the reliability of the carrier-rocket and constructive perfection of the spaceship satellite.

Hence we have the means for a man-in-space flights.

The first manned space flight opens out a new - space era in the history of mankind.

The time has come to put into practice projects, which previously seemed fantastic, - time to construct extraterrestrial scientific stations-laboratories, space voyages of a man to the moon, to mars, to venus and other planets of the solar system.

The new space era in the history of mankind - is the era of colossal expansion in the sphere of life and activity of mankind, era of conquest by a man of the circumsolar space.

"Pravda", 25 April 1961.

DAWN OF SPACE ERA

General meeting of the Academy of Sciences USSR, dedicated to the first manned space flight.

A general meeting of the Academy of Sciences USSR was held yesterday in the Moscow Club of Scientists, dedicated to the manned space flight.

The introductory speech was made by M. V. Keldysh, the newly elected President of the Academy o Sciences USSR, and was warmly greeted by all the present.

Speech by the President of the Academy of Sciences USSR.

Comrades! On the 12 of April 1961 the whole world witnessed an outstanding event in the history of mankind - the first in the world space flight of Yu. A. Gagarin Soviet pilot-cosmonaut on a Soviet spaceship satellite "Vostok". This event marks a great lanmark - penetration of a man into space.

In front of mankind now opens out an extensive prospect of space flights, mastering of the solar system planets and the study of the universe depths.

The successes of the Soviet Union in the mastering of space are recognised by the whole world.

On the 4 of October 1957 the Soviet Union launched the first in the world artificial earth satellite. In November 1957 and in May 1958 the second and third earth satellites were launched.

The launchin of these satellites laid the foundation for systematic space investigations, enabled the Soviet scientists and designers to begin getting ready for a man-in-space flights and opened the possibility of interplanetary communications.

Right from the start the work of Soviet scientists and designers was directed toward the construction of powerful carrier-rockets, capable of placing into orbit heavy statellites and to accomplish space flights of large objects.

Only due to construction in our country of powerful rocket engines, very precise systems for the control of rocket flights and high constructive perfection of the rockets themselves was it possible to progress rapidly in the mastering of the outer space.

1959 was marked by further forward steps. Soviet Union during one year has launched three space rockets. The first of these became the first artificial planet - satellite of the sun. The second along a precisely calculated trajectory reached the moon, brought to lunar surface scientific instruments and delivered pennant of the Soviet Union. The third placed automatic interplanetary station into lunar orbit and made it possible to photograph lunar surface, never seen from the earth.

The flight of these rockets indicates high perfection and accuracy of the Soviet automatic control systems, permitting automatic placing of the last rocket stages into prescribed trajectories. The implementation of these trajectories required importing to the last stage velocity of about 11000 m/sec with accuracy of upto 5 m/sec and to give the initial direction of the flight with accuracy into a few angular seconds.

The next step on the way to penetrating into the depths of the outer space was the launching in the Soviet Union on the 12 February 1961 of a venusian probe. In this case our scientists and engineers used a new principle for placing a space vehicle onto the interplanetary way - takeoff of controllable rocket from aboard a heavy earth satellite. This takeoff opened out new possibilities for the interplanetary flights, since in this case the need is eliminated for selecting definite period for the moon shots, there is the possibility of launching heavier space vehicles toward venus and other planets, the restrictions are eliminated, connected with the fact, that not every takeoff point on earth is similarly suitable for realization of the flight.

Development in the sphere of rocket technique enabled scientists and designers to begin construction of spaceships satellites for a manned space flights. In this they had to overcome difficulties in resolving a number of most composite scientific and technical problems: construction of automatic orientation systems, special devices for high accuracy of prescribed maneuver of the spaceship in orbiting (velocity decelleration of trajectory correction), construction of a reliable system for descent of the spaceship to earth, thermal control, regeneration, conditioning systems, enabling a prolonged stay of a man in space.

During the last three years investigations on satellites, space rockets and spaceship satellites provided an entirely new information about the upper atmospheric layers, outer space surrounding the earth, and interplanetary space.

Discovery has been made of the external radiation belt of the earth, which consists of charged particles, captured by the magnetic field of the earth. It has been established, that the outer most portion of the radiation belt extends to a distance of about 70-100 km from the earth's surface. On the other hand, it was found that the "offshoots" of the external and internal radiation belts come down to altitudes 200-300 km from the earth's surface. The intensity distribution of the cosmic rays is now known throughout the Globe at altitudes of 300 km and detection made of separate considerable intensity increments, in particular, the anomaly in the southern portion of Atlantic Ocean. New data were obtained on the composition and structure of the earth's atmosphere. It was found, that the earth's atmosphere extends as a "corona" of hydrogen atoms considerably further, than previously assumed. Concentration trend of charged particles (electrons and ions) is now known to altitudes of about 20,000 km, which is of enormous significance for the propagation study of radio-waves. Data were obtained on the density of matter in the interplanetary space and for the first time the flux was recorded of charged particles, ejected by the sun. Also tant information was obtained on the chemical composition of the primary cosmic radiation and short-wave radiation of the sun.

Space rockets have brought to us the data, unattainable for centuries, on the properties of remote outer space, on the absence of lunar magnetism, about the surface of the other side of the moon.

Investigations on satellites and space rockets open out further greater prospects in the study of circumterrestrial space, planets of the solar system and remote depths of the universe. Construction of satellites - astronomical observatories will enable to obtain new data on the planets, sun, stars and nebulae, will open new possibilities in astrophysics. Space rockets will deliver automatic scientific stations to the moon and the nearest planets of the solar system and will provide new information about their structure and physical properties. The possibility is being opened for the study of life forms in the new worlds.

Even now the use of the satellites provides great possibilities for the national economy. There will be a new way for resolving the problems of weather forecast, of the state of ionosphere, sun service. Construction of retranslator satellites and communication satellites will radically improve radio and television transmissions throughout the globe. These will be only the first steps in this direction.

The launching of the first spaceship-satellite in May 1960 initiated the experimental improvement and checking of the reliability of the spaceships systems for the manned flight. The subsequent launching of the spaceships satellites with animals and mannequin of a man have given an assurance to our scientists and designers of the possible flight of a man on the spaceship-satellite and his safe return to earth.

On the 12 of April 1961 the brave son of our motherland, pilot-cosmonaut Yurii Alekseevich Gagarin accomplished during 108 minutes an impetous and triumphal space flight around the earth on a spaceship satellite "Vostok", constructed by the creative genius of the Soviet people.

This flight caused admiration and rejoicing throughout the world. The 12 of April 1961 - is the first day of the epoch of the man's penetration into the outer space.

Gagarin's flight has opened an era of new superfast communications. It proved the possibility of constructing inhabited satellites and interplanetary stations, the way for construction of which was forecast by our great countryman K.E. Tsiolkovskii. The Soviet people have opened to mankind the ways of penetration into the universe and to master the riches of the new worlds.

It is significant, that the first man, who accomplished space flight, is a Soviet man and that the first flight was on a Soviet space-ship satellite. The progressive public of all countries has justifiably estimated this flight as a new invaluable contribution of the Soviet people for peace and progress of humanity. The historic feat of Gagarin once again demonstrated to the world the creative genius power of the Soviet people, who for the first time built-up a socialist society and is firmly progressing on the way of building communism under the leadership of the most forward party in the world - Communist Party of the Soviet Union.

Allow me to open the general meeting of the Academy of Sciences USSR, dedicated to the first man-in-space flight.

Thereafter the scientists listened to report of academician A.A. Blagonravov on the preparation of man-in-space flight. The speaker made a brief historical review of the development of these investigations, beginning from the vertical launching of rockets. He described the enormous significance of the first and subsequent Soviet artificial earth satellites in the investigations of the outer space, high quality of research, recording and other systems, as well as the life support systems, developed by the Soviet specialists.

Cosmos uncovers its mysteries.

The academician Blagonravov mentioned some new achievements of Soviet science in the sphere of space physics.

Beginning from the 2 of January 1959, in every flight of Soviet space rockets radiation was investigated at great distances from the earth. Detected by Soviet scientists the so called external radiation belt of the earth was investigated in detail. Study of the composition of particles in the zones by means of various scintillation and gas-discharging counters, carried on satellites and space rockets, made it possible to fix, that the external zone contains electrons of considerable energy upto a million of electron-volts and even higher. With deceleration they build up in the shells of spaceships a high-intensity piercing X-rays. During the flight of venusian probe determination was made of the average energy of these X-rays at 30 to 40 thousand km from the earth center, composing about 130 kilo-electron-volts. This magnitude varied little with the change in distance, which enables to judge, that there is a constant energy spectrum of electrons in this region.

Even the first investigations have shown instability of the external radiation zone, shifting of intensity peaks, connected with magnetic storms, induced by the solar corpuscular flux. The last measurements from the venusian probe have shown, that although nearer to earth there are changes in intensity, the outer boundary of the external zone with calm state of magnetic field remained practically invariable for two years both in intensity and in spatial arrangement. Investigations of the last years have enabled also to plot a model of the ionized gaseous envelope of the earth on the basis of experimental data for a period, nearest to the peak of the solar activity. Our investigations have shown, that at altitudes below thousand km the main role is of atomic oxygen ions, whereas from altitudes between one and two thousand km in ionosphere the predominance is of hydrogen ions. The extent of the outer most region of the ionized gaseous envelope of the earth, the so called hydrogen "corona", is very great.

Data processing of measurements, conducted on the first Soviet space rockets, has shown, that at altitudes approximately 50-75 thousand km beyond the external radiation zone is a flux of electrons with energies above 200 electron-volts. This permitted to assume existence of the third outer-most zone of charged particles with high flux intensity, but lower energy. After the launching in March 1960 of American space rocket "Pioner V" data were obtained, which confirmed our assumptions about the existence of the third zone of charged particles. This zone, apparently, forms due to penetration of the solar corpuscular flux into peripheral regions of the earth's magnetic field.

New data were obtained in relation to the spatial arrangement of the earth's radiation zones, a region was detected of the higher radiation in the southern part of Atlantic Ocean, which is connected with corresponding magnetic earth anomaly. In this area the lower boundary of the internal radiation belt of the earth comes down to 250-300 km from the earth surface.

The flights of the second and the third spaceship-satellites provided new data, which enabled to compose distribution map of radiation in the intensity of ions above the surface of the Globe. (The speaker showed this map to the audience).

For the first time currents, induced by positive ions in the composition of solar corpuscular radiation, were recorded outside the magnetic field of the earth at a distance in the order of hundreds of thousands km from the earth, by means of charged particles three-electrode traps, fitted on the Soviet space rockets. Specially on the venusian probe traps were set up oriented on the sun, one of which meant for recording of solar corpuscular radiation. On the 17 of February, during communication session with the interplanetary station, recording was made of its passage through considerable flux of corpuscles (with density of about 10^9 particles/sq.cm per second). This coincided with the observation of magnetic storm. These type of experiments provide the possibility for fixing quantitative ratio between the geomagnetic disturbances and intensity of solar corpuscular flux. On the second and third spaceship-satellites quantitative study was made of the radiation danger, caused by cosmic radiations beyond the earth's atmosphere. The same satellites were used for the chemical composition investigation of the primary cosmic radiation. The new equipment, carried on the spaceships satellites, included photoemulsion device for exposure and development directly on board of spaceship a stack of thick-layered emulsions. The obtained data are of high scientific value for elucidating biological effect of cosmic radiations.

Technical problems of the flight.

Thereafter the speaker mentioned number of principal problems, which ensured the manned space flight. Primarily it was necessary to resolve the problems on the methods for the placing into orbit of a heavy spaceship, which required a powerful rocket. This rocket we had. However it was insufficient to impart to the spaceship velocity, exceeding the orbital velocity. High precision was also required for the spaceship's entering into a prescribed orbit.

It should be kept in view, that demand for accuracy in orbiting will hence increase. This will require trajectory correction by means of special propulsion systems. Added to the problem of trajectory correction is the proble of directional change maneuver in the flight path of the spaceship. The maneuveres could be accomplished by means of impulses, transmitted by jet engine at individual specially selected branches of trajectory, by means of thrust acting for a long time, to build up which the application is made of ion engines or plasma jets.

As an example of maneuver it is possible to point out transition to a higher orbit, transition to a lower orbit, entering the dense atmospheric layers for deceleration and landing in a prescribed area. The latter type of maneuver was used in the landing of Soviet spaceships satellites with dogs aboard and in the landing of spaceship satellite "Vostok".

To accomplish the maneuver, implementation of a number of measurements and other aims it is necessary to ensure the stabilization of the spaceship satellite and its orientation in space, maintained for a certain time interval or changed according to prescribed program.

Passing on to the problem of returning to earth, the speaker paused on the following questions: velocity deceleration, protection from overheating with the movement in dense atmospheric layers, ensuring landing in prescribed area.

Deceleration of spaceship, required to quench cosmic velocity, could be implemented either by means of a special powerful propulsion system, or by braking the vehicle in the atmosphere. The first of these methods requires very high reserves of weight. The use of atmospheric resistance for deceleration makes it possible to manage with comparatively low additional weight.

The set of problems, connected with the development of protective coating with deceleratior of vehicle in the atmosphere and entry with overstrain bearable for a human organism, is a very composite scientific and technical problem.

Vigorous development of the space medicine set up the question of biological telemetry as the basic means of medical checking and scientific medical investigation during the flight. The use of radio-telemetry imposes a specific imprint on the methods and technique of medico-biological investigations, since the equipment, carried aboard the spaceships, has to have a number of requirements. It should have very low weight, small overall dimensions. Its power consumption should be minimum. Moreover the equipment aboard should have stable performance in propulsion branch and with descent, when the vibrations and overstrains are active.

The transducers of physiological parameters into electric signals, should be very small, estimated for long service. They should not cause any inconvenience to the spaceman.

The widespread application of radiotelemetry in space medicine forces the investigators to pay serious attention to construction of equipment, and also to coordination of the volume of required information with capacity of radio channels. Since the new problems facing space medicine will result in further deepening of investigations, in the need for considerable increment of recorded parameters, introduction will be required for systems, memorising information and methods of coding.

In conclusion the speaker paused on the question, as to why the selection for the first space voyage was the earth orbiting. This was a decisive step in the mastering of the outer space. It provided for the investigation of the flight duration effect on a man, the problem was being resolved of controlled flight, entry into dense atmospheric layers and safe return to earth. In comparison with this the flight accomplished recently in the USA is of low value. It could have been of significance as an intermediate version for the checking of a man's state in acceleration, with overstrain during descent; but after the flight of Yu. A. Gagarin there was no need for this checking. In this experiment the predominance was of the sensation element. The only value of this flight could be the performance checking of the systems for entry and landing, but, as we have seen checking of similar systems, developed in the Soviet Union for more composite conditions, was reliably carried out even before the first manned space flight. Thus there can be no comparison between the achievements in USSR on the 12 of April 1961 and what was achieved until now in USA.

And, said the academician, no matter how the hostile to the Soviet Union people abroad tried to minimize our achievements in science and technique, the whole world properly appreciates these achievements and can see, how far ahead is our country in technical progress. I was personally a witness with what enthusiasm and admiration the masses of Italian people have greeted the message about the historic flight of our first spaceman.

<u>The flight was exceptionally successful.</u>

The academician N.M. Sisakyan spoke on the biological problems of the space flight. He described the main stages in the development of space biology and summarised some of the results of biological investigations, connected with space flights.

The speaker cited medico-biological characteristics of Gagarin's flight. Barometric pressure in the cabin was maintained at 750-770 mm Hg, temperature at 19-22°C, relative humidity at 62-71%.

During the pre-start period, approximately 30 minutes prior to take off of the spaceship, the heart beat rate was 66/minutes, respiration rate - 24. Three minutes prior to takeoff some emotional tension was noted in the increment of pulse upto 109 beats per minute, the respiration remained even and steady.

At the moment of takeoff and gradual acceleration the heart beat rate increased upto 140-158 per minute, respiration rate was 20-26. Variations of physiological indices in propulsion branch, according to data of telemetric recording of electrocardiograms and pnemograms, were within the tolerance limits. At the end of propulsion branch the heart beat rate was down to 109, and of respiration - 18/minute.

In other words, these indices reached values, typical of the nearest to takeoff moment.

With transition to weighlessness and the flight in this condition the indices of the cardio-vascular and respiration systems subsequently approximated the initial values. Thus, even at the tenth minute of weightlessness the pulse rate reached 97 beats/minutes, of respiration - 22. The efficiency was not disrupted, movements retained coordination and the required precision.

On the descent path, with deceleration of vehicle, when the overstrain was active again, brief, quickly passing periods were noted of increased respiration rate. However even on the approach to the earth the respiration became even, calm, with the rate of about 16/minute.

Three hours after landing heart beat rate composed 68, respiration - 20/minute, i.e. quite normal for Yu.A. Gagarin.

All this proves, that the flight was exceptionally successful, general feeling of the spaceman at every branch of the flight was satisfactory. Life support systems operated normally.

In conclusion the speaker mentioned the most important problems of space biology.

"Pravda", 20 May 1961.

TASS COMMUNIQUE ON THE LAUNCHING OF SPACESHIP SATELLITE "VOSTOK-2"

On the 6 of August 1961 another spaceship "Vostok-2" was launched in the Soviet Union into earth orbit.

The spaceship "Vostok-2" is piloted by the citizen of the Soviet Union flight Major comrade Titov Herman Stepanovich.

The taske of the flight are :

- effect investigation on human organism of prolonged orbiting and subsequent descent to earth surface;
- efficiency investigation of a man during a long period in conditions of weightlessnesss.

According to preliminary data the spaceship satellite was placed into a prescribed orbit of the following parameters:

- perigee distance 178 km;
- apogee distance 257 km;
- orbital inclination - 64°56'.

The initial orbiting period of the spaceship satellite is 88.6 minutes. The weight of "Vostok-2" without the last stage of carrier-rocket is 4731 kg.

A two-way radio-communication has been established and is maintained with the pilot-cosmonaut comrade Titov.

The pilot's transmissions are on frequencies 15.765, 20.006, 143.625 megacycles per sec.

The spaceship carries also transmitter "Signal", operating on frequency 19.995 megacycles per second.

The life support systems on board operate normally.

Comrade Titov Herma Stepanovich is feeling well. The flight of the Soviet spaceship controlled by a man, proceeds normally.

Tass communiques on further flight will be regularly transmitted by all the radio stations of the Soviet Union.

STATEMENT OF H.S.TITOV PRIOR TO TAKEOFF.

Dear comrades and friends!

The honour has fallen to accomplish another flight into the universe on Soviet spaceship "Vostok-2".

It is difficult to express in words the feelings of joy and pride which fill me.

We, the Soviet people, are proud of the fact, that our beloved motherland has opened a new era in the mastering

- [illegible] -

of the outer spa[illegible], [illegible] been entrusted with honourable and re[illegible] [illegible]

[illegible]

[illegible]

technicians and workers, who constructed the beautiful spaceship "Vostok-2" and made it ready for the flight.

The new space flight, which I am to accomplish, I dedicate to the XXII convention of our own Communist Party.

At these minutes I would like once again to thank the Central Committee of the Lenin's Party, Soviet Government for their trust in me and to assure them, that I shall apply all my powers and skill, to carry out the honoured and responsible task.

I am convinced of the success of the flight.

See you soon, dear comrades and friends!

"Pravda", 7 August 1961.

Pages from biography.

Herman Stepanovich Titov was born in 1935 in Verkhnee Zhilino village, Kosikhin district, Altai region, in the family of Middle school teacher. In nationality - Russian. In 1943 entered a primary school at collective farm "Rainloe utro" Kosikhin district, where to his mother moved at the start of the war.

In 1950 he finished the seven-year school in village

Polkovnikovo Kosikhin district, and then Malobikhin middle school of the same area. In 1949 H.S. Titov entered a military-aviation school, which he finished in 1957 in first division, getting "excellent" for the test in piloting technique.

On finishing the school H.S. Titov was sent for service into Leningrad command. He was granted two certificates of merit for military tactics and politics and exemplary military discipline.

Comrade Titov is a candidate for a membership of the CPSU.

He is married. His wife - Tamara Vasil'evna was born in 1937.

His father - Stepan Pavlovich, born in 1910, was a teacher of Russian literature, thereafter of German language in the seven-year school in village Polkovnikovo of Altai region. Since 1961 lives on pension. Mother - Aleksandra Mikhailovna was born in 1914.

LISTEN, WORLD! FLASHING "VOSTOK-2".

Communique from aboard the spaceship. First report to Motherland.

While flying above the territory of the Soviet Union at 10 hours 35 minutes Moscow time, the pilot-cosmonaut comrade Titov transmitted greeting to the Central Committee CPSU, Soviet Government:

Moscow, Kremlin

I am reporting from aboard the Soviet spaceship "Vostok-2" to CC CPSU and the Soviet Government: the flight of Soviet spaceship "Vostok-2" is proceeding normally. Function of all the systems perfect. I feel well. Give my regards to the whole Soviet people.

Cosmonaut Titov.

"Pravda", 7 August 1961.

TASS COMMUNIQUE. THE FLIGHT CONTINUES.

The flight of the Soviet spaceship satellite "Vostok-2" with cosmonaut comrade Titov aboard proceeds successfully, in accordance with the program. At present the spaceship-satellite completes its third orbital period. A two-way radio-communication is being maintained with the cosmonaut on short and ultrashort waves. Radio-stations of the Globe can listen-in to comrade Titov on short waves with frequency 15.765 and 20.006 megacycles per second and ultrashort waves with frequency 143.625 megacycles per second. The board transmitter is ultrashort wave with frequency modulation. Frequency deviation ± 30 kcps.

The received TV pictures of the spaceman, telemetric information of his condition and on climatic conditions in the space cabin indicate normal course of the spaceman's flight. Comrade Titov feels very well. The flight assignment is being implemented by Maj. Titov in accordance with the program. The space flight is continuing.

The spaceship satellite "Vostok-2" is passing above London (Moscow time) at 13 hours 33 minutes. Ulan Bator - 13 hours 50 minutes, Sydney - 14 hours 14 minutes, Novosibirsk - 15 hours 16 minutes, above Caracas - 16 hours 17 minutes, Sverdlovsk - 16 hours 44 minutes Calcutta - 16 hours 55 minutes, Washington - 17 hours 54 minutes, Moscow - 18 hours 12 minutes, Chicago - 19 hours 24 minutes, Berlin - 19 hours 42 minutes, Adis Ababa - 19 hours 55 minutes.

On the second revolution around the earth the spaceman Maj.Titov transmitted a number of communiques from aboard the spaceship "Vostok-2", indicating, that the flight is proceeding successfully.

The construction of the spaceship satellite and its equipment operate normally.

Comrade Titov feels very well.

The two-way radio-telephonic communication with the spaceman on ultrashort and shortwaves is quite clear.

The spaceman and his work with instruments is observed from the earth on TV lines.

While flying above Africa Major Titov transmitted greeting to the peoples of Africa.

The condition of the spaceman and performance of the ship's equipment is being checked by telemetry. According to the reading of devices the condition of the spaceman is good, pulse rate 88, respiration - 15-18 per minute. Normal conditions are maintained in the cabin for life support.

At 11 hours 48 minutes (Moscow time) the spaceship satellite "Vostok-2" completed second revolution around the earth and began the third.

At 15 hours Moscow time the Soviet spaceship satellite "Vostok-2" completed its fourth revolution around the earth.

During the revolution, while flying above Europe, Maj. Titov transmitted from aboard the spaceship satellite greeting to the peoples of the Soviet Union and Europe.

At the end of the third revolution, from 12 hours 30 minutes to 13 hours comrade Titov took his lunch. The lunch of the spaceman consisted of three dishes. At the end of the lunch the cosmonaut transmitted: "Had my lunch, feel excellent".

During the fourth orbital period the spaceship satellite passed above Madrid, Paris, Copenhagen, Leningrad, Ulan-Ude, Shanghai, Sydney. At the start of the fourth orbital period in accordance with the flight program, the spaceman took an hours rest. After the rest he did some exercises and then began further implementation of the work, envisaged by the flight assignment.

At the end of this revolution, being above South America, Maj. Titov transmitted greeting to the people of South America.

In reports, transmitted from aboard the spaceship satellite "Vostok-2", Maj. Titov informs of the non-failure functioning of the whole equipment, set up on the ship. For an hour Maj. Titov conducted tests of the spaceship's manual control.

On completing the tests he reported excellent controlability of the spaceship satellite in maneuvering by means of manual control.

During the fifth orbital period the spaceship satellite will pass above Edinburgh, Arkhangelsk, Novosibirsk, Kwangchow, Melbourne, Lima.

During the seven hour flight around the Globe the Soviet spaceship "Vostok-2" flew 200,400 km. During the fifth orbital period Maj. Titov communicated: 15 hours 07 minutes: "Order aboard, I feel well"; 15 hours 06 minutes "program of the fourth orbital period completed"; 15 hours 30 minutes: "Flying above, equator, weightlessness does not bother me".

During the flight above the Soviet Union pictures were received through radio-TV system, showing calm and smiling face of the Soviet spaceman; along the multichannel radio-telemetric system continued arriving extensive information of scientific nature, and also detailed data on functioning of systems aboard the spaceship satellite "Vostok-2".

While flying above Kwangchow Maj. Titov transmitted greeting to the peoples of Asia, and when flying above Melbourne greeted Australian people.

During the eight and a half hours of flight the "Vostok-2" flew 238,400 km and at 17 hours 42 minutes completed sixth revolution around the earth. At 16 hours 31 minutes Herman Stepanovich Titov informed: "Feeling well, everything is in order". At 16 hours 37 minutes comrade Titov again confirmed his well-feeling and transmitted reading of the board instruments. At 16 hours 48 minutes he communicated: "Pressure in the cabin invariable. Humidity 70%, temperature 20°. Full comfort!". At 16 hours [illegible] minutes a radiogram was transmitted aboard the spaceship "Vostok-2" to Maj. Titov from Yurii Alekseevich Gagarin, pilot-cosmonaut of the USSR:" Dear Herman! My heart is with you. Heartily embrace you old chap. Affectionately kiss you. I watch your flight with excitement, I am sure it will be successfully completed and once again bring fame to our great motherland, our Soviet people. See you soon.

Yours Yurii Gagarin".

Comrade Titov confirmed reception of comrade Gagarin's greeting and expressed his sincere gratitude.

All the equipment of the spaceship operates normally. The spaceman continues to feel well, his mood is cheerful. The efficiency is fully retained.

No deviations are noticed of cardio-vascular and respiration systems. Pulse rate 80-100, respiration - 20-[illegible] per minute. Data of electrocardiograms are practically not different from initial, recorded on earth. According to telemetry data all the life support equipment operates normally. Temperature within the cabin varies within limits 20-22°, pressure - within 750-760 mm Hg. Relative humidity about 70%, oxygen content about [illegible]%, carbon dioxide - 0.5%.

At 17 hours the spaceman took his dinner. At 17 hours [illegible] minutes spaceship "Vostok-2" began its seventh revolution around the earth, during which it will pass along the eastern coast of North America, above Iceland, Scandinavia, towns [illegible], Tambov, Astrakhan, Eastern

Iran and further - above the Arabian Sea, Indian and Pacific Oceans.

The flight of spaceship "Vostok-2" continues.

The distance passed is greater, than from earth to the moon

Continuing his flight on spaceship "Vostok-2", Herman Stepanovich Titov at 18 hours 00 minutes had flown six times around the earth. The spaceman had again switched the manual control and the ship obediently followed the movement of the spaceman's hand.

The pilot-cosmonaut still feels well. All the equipment operates unfailingly. The ship moves in complete accordance with prescribed program.

At 18 hours 15 minutes Moscow time the spaceman, flying above Moscow, transmitted:

Dear Moscowites! In the cabin all as before. Pressure normal, excellent. Humidity 70%. Temperature 18°C. Absolute comfort. Everything is well, excellent. Request to transmit to dear Moscowites good night".

In accordance with the flight program from 18 hours 30 minutes of 6 August till 2 hours of 7 August the time is alloted to the spaceman for rest and sleep, therefore the two-way radiocommunication with him is temporarily off. Radio-telemetric checking of the spaceship equipment, life support system and the state of the spaceman is continuing.

According to the latest data of radio-telemetric checking, the pulse of the cosmonaut in sleep is normal - 58 beats/min.

The spaceship satellite "Vostok-2" could be observed during the flight with clear sky visually as a star of the first magnitude after the sunset within a range from [illegible] to [illegible] and before sunrise - from 38 to 52° S. By [illegible] hours [illegible] minutes the spaceship satellite "Vostok-2" has completed ten revolutions around the earth and flew 410 thousand km, which is greater than the distance to the Moon.

According to radio-telemetric data, the equipment of the spaceship functions normally. The state of the spaceman is good. At 23 hours 26 minutes Moscow time his pulse rate was 58/min.

The flight of the Soviet spaceship satellite "Vostok-2" successfully continues.

"Pravda", 7 August 1961.

TASS COMMUNIQUE HOW THE FLIGHT WAS PROCEEDING:

Pilot-cosmonaut Herman Stepanovich Titov by 3 hours Moscow time on the 7 of August 1961 has completed 12 revolutions on spaceship "Vostok-2", having flown 537,300 km. The orbital parameters of the spaceship continue to be close to calculated one.

In accordance with the time-table from 18 hours 30 min on 6 August till 2 hours on the 7 of August Maj. Titov had to rest (sleep). The spaceman awoke at 2 hours 37 min and began working according to time table.

From aboard the spaceship "Vostok-2" Maj. Titov informed, that he slept well, all the equipment of the spaceship operates normally, the prescribed hygienic conditions in the cabin are being maintained, he feels very well.

The communication with the spaceship is excellent.

During the sleep the pulse rate of the spaceman was within the limits from 53 to 67 beats per minute.

Continuing flight on the spaceship "Vostok-2", Maj.Titov H S. has entered at 6 hours Moscow time 15th revolution around the Earth. The spaceman continues to feel well. Having had a good breakfast at 5 hours 45 min, the spaceman is continuing the tasks, prescribed by the program of scientific investigations.

The spaceship satellite "Vostok-2" carried numerous devices. They include radio-technical system of trajectory measurements;

multichannel telemetric systems, providing for objective observation of the spaceman's condition and performance checking of all the equipment aboard; the reception - transmitting shortwave and ultrashort wave communication equipment, including tape-recorder, meant for recording of the spaceman's talk and automatic accelerated reading of recording of command from the Earth.

During the rest the spaceman can use the broadcasting receiver for reception of programs on medium and short waves. TV systems enable to observe regularly the work of the spaceman. A whole set of life support systems assures normal conditions in the space cabin.

Aboard the spaceship are various scientific instruments. Biological objects are present aboard for obtaining additional data on the effect of cosmic radiation on life forms. During the flight the Earth and the sky are observed through three illuminators. The spaceman may use if desired an optical device of three and five times magnification.

By 8 hours 20 min Moscow time the spaceship "Vostok-2" completed its 16th revolution around the Earth. By this time pilot-cosmonaut Maj.Titov has flown 654,800 km.

According to reports of Maj.Titov and telemetric data all the systems aboard operate normally. Successful implementation of the scientific investigations program is continuing.

The spaceman's feeling is excellent. The condition of weightlessness causes no trouble. The exact coordinated actions and the efficiency of the cosmonaut are fully retained. Normal life support conditions are maintained in the space cabin. Communication with the spaceship is quite steady.

The flight of the spaceship "Vostok-2" is continuing.
"Pravda", 7 August 1961 (Extra issue).

TASS COMMUNIQUE THE UNPRECEDENTED SPACE FLIGHT IS SUCCESSFULLY COMPLETED:

The soviet spaceship-satellite "Vostok-2", piloted by Maj.Titov, completed over 17 revolutions around the Globe during 25 hours 18 min and flew over 700 thousand km.

Due to successful completion of research program in accordance with confirmed flight assignment the spaceship "Vostok-2" landed in prescribed area of the Soviet Union in the vicinity of historic place of spaceship "Vostok-1" on the 12 of April 1961 with pilot-cosmonaut Maj.Yurii Alekseevich Gagarin.

Comrade H.S.Titov is well and is feeling excellent. The unprecedented prolonged space flight of the Soviet cosmonaut in the history of mankind is successfully completed. The obtained investigation results open out wide possibilities for further development of man-in-space flights.
"Pravda", 7 August 1961 (Extra issue).

TO COMMUNIST PARTY AND PEOPLE OF THE SOVIET UNION:
TO PEOPLE AND GOVERNMENTS OF ALL COUNTRIES: TO ALL PROGRESSIVE MANKIND:

Address of the Central Committee of CPSU, Presidium of the Supreme Council of USSR and the Government of the Soviet Union:

The Central Committee of CPSU, Presidium of the Supreme Council of USSR, Government of the Soviet Union announce with great joy the new unprecedented victory of the Soviet Science and technique - successful flight of the second spaceship with a man aboard.

On the 6 of August 1961 at 9 hours Moscow time a powerful Soviet rocket placed into earth orbit another spaceship satellite "Vostok-2", piloted by a citizen of the Soviet Union, communist, Maj. Titov H.S.

Comrade Titov has safely completed a 25 hour flight around the Earth and after implementation of the planned program successfully landed on the territory of our Motherland - Union of the Soviet Socialist Republics.

The Soviet spaceship "Vostok-2", piloted by comrade Titov, flew more than 17 times around the Globe, overcoming distance of over 700 thousand km., i.e. almost doubled distance from the Earth to the Moon.

This feat reflects the new enormous achievements of the Soviet Union, our science and technique, of the whole national economy - great advantages of the socialist society foremost in the world.

All nations of the world marked with great farvour and enthusiasm the first Soviet manned space flight. The remarkable flight of another Soviet spaceman shows, that the time is not far, when manned spacecrafts will pave the interplanetary way to the Moon, Mars, Venus. New wide prospects are opening to mankind for conquering the outer space and flights to planets of the solar system.

With a feeling of just pride the Central Committee of CPSU, Presidium of the supreme Council of USSR and the Government of Soviet Union remark, that our country, country of victorious socializm, confidently leads the mankind in the use of scientific and technical achievements to the good of humanity.

The second space flight of Soviet man in the earth orbit is a new and clear confirmation of the great might of the people, who built socialism. Our achievements in the mastering of the cosmos are not accidental, they reflect the regular progress of victorious communism. Communism irrepressibly forges ahead. And there is no power in the world, which could have prevented the indomitable striving of humanity toward its bright future.

The enemies of piece fan the war hysteria. We set-off against this hysteria our majestic plans of communist building, our firm confidence in our strength, in the correctness of the way, pointed out by Marxist-Leninist teaching.

All people on Earth know the plans and aims of our country. They are given in the project of a new program of the Communist Party of the Soviet Union, which is introduced for consideration at the XXII Convention of the CPSU - Program of building communist society. The communism is carrying out the historic mission of delivering all people from the social inequality, from all forms of depression and exploitation, from the horrors of war and consolidates on Earth Peace, Work, Freedom, Equality and Happiness of all nations.

Everything in the name of a man: Everything for the good of a man: - this is our supreme object.

Space flights of the Soviet people mark inflexible will power, inflexible desire of the whole Soviet people for lasting peace on Earth. Our achievements in space research we place to the service of peace, scientific progress, for the good of all the people on our planet.

Soviet people are firmly convinced, that peace will be victorious throughout the world. Peace will triumph if all the nations will selflessly flight for its strengthening.

We appeal to the Governments of all the countries, to all people, regardless of race, nation social affiliation and religious convictions to apply all their power for ensuring lasting peace on the Earth.

The new glorious victory of our Motherland inspires all Soviet people to even greater feats in the building of communism.

Forward to great victories in the name of peace, universal happiness and progress of humanity!

Central Committee of the Communist Party USSR	Presidium of the Supreme Council of USSR	Council of Ministers USSR.

To all scientists, designers, engineers, technicians, workers, all those participating in successful accomplishment of new manned space flight on the spaceship-satellite "Vostok-2" Soviet cosmonaut, who accomplished 25-hour flight comrade H. S. Titov.

Dear Comrades! Friends - Countrymen!

On the 6 of August 1961 our Motherland - Union of the Soviet Socialist Republics - has successfully accomplished a new daring step on the way of mastering the outer space.

Pilot - cosmonaut, heroic son of Communist Party, comrade Titov H.S. has completed a 25 hour flight on a Soviet spaceship "Vostok-2", orbiting our planet more than 17 times.

This is the greatest victory of our science and technique, brilliant manifestation of the creative genius of the Soviet people, firmly following the way of building communist society.

Only people, inspired by the great program of building communism, guided by our own Communist Party, are capable of accomplishing within such a short period the deeds, about which during many centuries dreamt the best men of Russian and universal sciences.

The Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of USSR and the Council of Ministers USSR warmly congratulate in the name of our glorious Communist Party, Soviet Government, all peoples of the Soviet Union all scientists, designers, engineers, technicians, workers, all those participating in construction and preparation of the spaceship satellite "Vostok-2" and successful accomplishment of space flight, with new great victory of mind and labor of the Soviet man.

Hearty congratulations to you, our dear comrade Herman Stepanovich Titov, on your great feat - new outstanding space flight.

Glory to our scientists, designers, engineers, technicians and workers - conquerors of the space!

Glory to our people - people-creator, people-conqueror, paving the way under the leadership of the Communist party to the bright future of all mankind - communism!

Long live the glorious Communist Party of the Soviet Union - inspirer and organiser of all the victories of the Soviet people!

Long live Communism!

Central Committee CPSU	Presidium of the Supreme Council USSR	Council of Ministers USSR.

"Pravda", 7 August 1961 (Extra issue).

DECREE OF THE SUPREME COUNCIL OF THE USSR ON THE CONFERING OF THE TITLE HERO OF THE SOVIET UNION SOVIET PILOT-COSMONAUT MAJOR TITOV H.S.

For accomplishing an outstanding space flight on spaceship satellite "Vostok-2" to confer title of the Hero of the Soviet Union with the order of Lenin and "Gold Star" medal to pilot - cosmonaut Major Titov Herman Stepanovich.

L. Brezhnev
Chairman of the Presidium of
Supreme Council USSR

M. Georgadze
Secretary of the Presidium of
Supreme Council USSR

Moscow, Kremlin, 9 August 1961.

DECREE OF THE PRESIDIUM OF SUPREME COUNCIL OF USSR CONFERRING A TITLE OF "PILOT-COSMONAUT OF USSR" ON FLIGHT MAJOR TITOV H.S.

For the flight on spaceship satellite "Vostok-2" to confer the title "Pilot-cosmonaut of USSR" on the citizen of Soviet Union Flt.Major Titov Herman Stepanovich.

L. Brezhnev
Chairman of the Presidium of
Supreme Council USSR.

M. Georgadze
Secretary of Presidium of the
Supreme Council USSR

Moscow, Kremlin, 9 August 1961

"Pravda", 10 August 1961.

THE DARING DREAMS OF MANKIND ARE COMING TRUE:

Press-Conference, dealing with the flight of Herman Titov:

Yesterday in the Act Hall of M.V. Lomonosov Moscow State University Press-Conference was held of the Soviet and foreign journalists on the successful flight of the second manned spaceship.

This meeting, arranged by the Academy of Sciences USSR and the Ministry of Foreign Affairs USSR, has greatly impressed all those present there. Taking part in this conference were the pilot-cosmonaut H.S. Titov Hero of the Soviet Union and the most prominent representatives of the Soviet Science and Technique.

The opening address was made by the academician M.V.Keldysh, President of the Academy of Sciences USSR.

The greatest achievement of the Soviet Science:

The speech of M.V. Keldysh:

Comrades, Ladies and Gentlemen!

On the 6 of August 1961 at 9 hours Moscow time another lunching was carried out in the Soviet Union into the orbit of earth satellite of a multiton spaceship "Vostok-2", manned by the Soviet pilot-cosmonaut comrade Titov Stepanovich.

Comrade Titov during 25 hours 18 min had flown 700 thousand km., completing over 17 revolutions around the Earth and on the 7 of August at 10 hours 18 min landed in prescribed area on the territory of the Soviet Union.

It was only on the 12 of April of this year, that the world renowned Soviet cosmonaut Yurii Gagarin accomplished the first earth orbiting on spaceship-satellite "Vostok-1", opening the era of space flights. Within a period of less than four months Herman Titov accomplished a prolonged space flight. His space trip was equal to the distance from the Earth to the Moon and back, and safely returned to his native land. Quite justifiably the feat of Yurii Gagarin was compared with the feat of Columbus and Maggelan. The flight of Herman Titov is not comparable to anything known in history of mankind. This flight is a new gigantic step on the path of conquering the outer space, new historic victory.

The remarkable flight of the spaceship-satellite "Vostok-2" is the greatest achievement of the whole Soviet Science and technique, of the whole Soviet people. The exceptional achievements of the Soviet Union in rocket technique our country has placed at the service of peace and progress of mankind.

The flights of the Soviet spaceships-satellites show, that the time is approaching, when the man will be able to penetrate far into the outer space, to accomplish the centuries-old dreams of flights to the Moon, Mars, Venus and in even more remote depths of the Universe. The mankind has entered into a new epoch of mastering the innermost secrets of nature, concealed within the depths of cosmos. The new phenomena, which we'll meet at other planets will be used for improvement of life on the Earth.

The spaceship "Vostok-2" is the greatest achievement of scientific and designing thought. It has all the conditions for a prolonged space flight. It has equipment for the automatic control of flight and landing on the Earth. At the same time the possibility has been provided for changing to manual control directly by the spaceman. The latter may accomplish the research required for maneuveres in the orbit and may land at any point of the Globe. There are also means for continuous communication of the spaceman with the Earth. Throughout the flight the spaceman carried on talking, informin about the performance of equipment, implementation of the flight program, of his observations and feeling. He continuously received communications from the Earth. The spaceship satellite was equiped with instruments for investigating conditions of space flight and obtaining reading of the spaceman's state.

The flight of the spaceship provided most valuable scientific results. These results will be published after their processing and will be available to all the scientists of the world.

Herman Stepanovich Titov, remarkable son of the Soviet people, pupil of our glorious Communist Party, has shown great courage and valour, skill and self - discipline and has brilliantly conducted the responsible, composite space flight. He accomplished his feat in the name of science, to the glory of our wonderful Soviet Motherland, in the name of the peace and progress of humanity.

Dear Herman Stepanovich! The whole Soviet people, all mankind watched with bated breath your unprecedented flight. Soviet people have given you a rousing reception on your return to native land, on your return to our Capital - Moscow. The Party, Government, the whole Soviet people have highly valued your immortal feat. The great title has been conferred on you of the Hero of the Soviet Union and the title of Pilot cosmonaut of the Soviet Union.

Permit me to greet you, dear Herman Stepanovich on behalf of the Academy of Sciences, all scientists of the Soviet Union, on behalf of all those gathered in this hall.

The Academy of Sciences of the Soviet Union, taking into account the enormous significance of your space flight for the science, for cosmonautics, has awarded you the gold medal, bearing the name of K.E. Tsiolkovsky, the founder of the theory of rocket technique and space flights.

The academician M. V. Keldysh hands over the award of honor to Herman Titov.

Address of H.S. Titov. About the flight:

Comrades, Ladies and Gentlemen!

You can, probably, guess, that meeting correspondents is not a usual affair for me. It is difficult for me to convey to you the unusual things, which I have seen and felt in the space, to tell you why this twenty five hour space flight has became possible.

The difficulty is also in the fact, that for me this flight seems a natural event, I have been long in training for this flight and it became as though a habitual one, but you all expect from me something unusual, unusual feelings and impressions.

I will try to tell you about the flight to the best of my ability, pass on to you my impressions.

What is the cause of the flight's success? What gave me the assurance of the flight's success?

First, I knew very well, that the spaceship was made by our scientists, engineers, technicians and workers. I have thoroughly studied the spaceship. The spaceship, its construction and equipment have been repeatedly tested in flight.

Secondly, I knew, that everything, which assures life support to a man in the space cabin, was tested in numerous experiments on land and in flight.

Thirdly, as you, probably, know, I'am by profession a fighter-pilot. In flights on modern fighter-planes acute situations are inevitable, requiring instantaneous discovery of the cause and lightning like reaction. In fighter-pilot should be cultivated a unique automatism, in which thinking should be blended with action, an automation in which it is difficult to decide, what comes first- action or thinking. Thus, the experience of flying fighter-planes has greatly helped me in this space flight. Moreover, for a long time I have been training for the flight on this spaceship.

And, of course, the moral factor.

I knew, every second remembered and was proud of the fact, that the Soviet people, the Party and the Government have entrusted this flight to me. The feeling of pride for my Motherland and the trust shown in me inspired me. This is the fourth and, perhaps, the decisive factor of the successful flight.

Perhaps you are very interested in the way the flight was going on?

The rocket tookoff from the Earth at exactly 9 hours Moscow time.

The overstrain, noise and vibration during the insertion I endured quite well without any unpleasant sensations. I carried on observations during this period through illuminators and of instruments, maintaining a two-way radio-communication with the Earth.

After the engine cutoff of the last stage, the weightlessness has set in. The first impression (the first few seconds) I'am flying with my feet up. However after a few seconds everything became normal.

The Sun was peeping into the illuminators, it was light in the cabin - the light could be switched off in the cabin.

When the Sun was not in the illuminators, it was possible to watch simultaneously, the sun-lit Earth and stars - clear and bright points against a very black background.

The instruments have shown, that the spaceship entered an orbit. It was confirmed from the Earth, that the space ship entered a prescribed orbit. Therefore I could begin the implementation of the assigned flight program.

Soon the spaceship entered into the Earth shadow. It is interesting to mention, that before coming out from the shadow it was possible to distinguish Earth from the sky. The Earth when not sunlit, was distinct from the sky by its light grayish color. It was even possible to mark the flight direction from the shifting of this grey shroud. The fact, that the Earth did not seem to a black void is, apparently, connected with the Moon, which although it was "on the wane", still reflected the sun's rays onto the Earth.

While still being in the shadow (10 hours Moscow time), I switched on in accordance with assignment the manual flight control of the spaceship.

To control the ship is easy, convenient, it should be oriented in any direction and at any mome t to direct it where ever required. I felt my self to be the master of the ship. It was obedient to my will, my hands. At the seventh revolution in accordance with research program I once switched on the manual control.

Simultaneously I conducted observations through illuminators and maintained radio-communication.

It should be mentioned, that during the whole duration of the flight a two-way communication was maintained with Earth on short and ultrashort waves. Even being at the most distant from USSR point of orbit, I communicated with the ground stations, listened to their communications and transmitted to them my own.

Besides the two-way communication equipment the spaceship carries broadcasting receiver. I listened to transmissions from Moscow and from other radio-stations.

On the second revolution informed the Central Committee of the CPSU and the Soviet Government about the flight procedure and soon received a telegram in reply.

During the flight I transmitted by radio greetings to my comrades, Muscovites, peoples of the Soviet Union, Europe, Asia, Africa, North and South Americas, Australia.

It was interesting to watch the Earth from space. It is possible to distinguish rivers, mountains cultivated fields (the plowed, unharvested fields, etc. differ in color). The clouds are clearly seen. They are easily distinguished from the snow by the shadow, which they throw on the Earth. Sometimes the Earth's horizon gets into the illuminator - very interesting picture - transition through all the colors of the rainbow from the litten up Earth to black sky, pale - blue halo. Sometimes it seems as though the Globe is hanging above my head-involuntarily the thought comes: "What holds it?".

Twice the crescent of the Moon swam past the illuminators. It is the same as we see it from the Earth. The Moon is just a Moon - nothing special.

During the flight normal climatic conditions were maintained in the cabin: pressure equivalent to atmospheric, temperature normal, gas composition of air the usual, no smell whatever in other words the air-conditioning system performed very well during the flight.

About 12.30 I had my lunch, and on the sixth revolution dinner, frankly speaking, I did not have much of an appetite - the effect could be felt of prolonged weightlessness and some excitement. But program is program, and I carried it out. The sanitary arrangement had to be used, of course, and operated perfectly.

From 7th to 12th revolution the program prescribed sleep and rest. This was implemented. I did not sleep soundly, sometimes I woke up. But afterward I went to sleep and ..... even over-slept the session of communication I was to begin at 2 hours Moscow time. I woke up at the start of the 13th revolution.

During the flight I carried out exercises and all sorts of self observation according to program, made up by our doctors.

The flight program was fully implemented.

At the start of the 17th revolution in accordance with the flight program, the automatic control, providing for descent and landing of the spacecraft in prescribed area were switched in. Juas as in the previous one, in this flight too the use was made of fully automatic o·ientation system. cutting of braking motor, control and descent. However, in case of need I could have landed the spaceship independently.

The spaceship was oriented, braking motor switched in and the spaceship changed to descent trajectory. Prior to descent I did not close the illuminator shutters and watched with interest the bright luminance of the air, stream-lining the spaceship with the entry into dense layers of atmosphere, and color variation of this luminance with the changing velocity and altitude. With appearance of overstrain the weightlessness has ceased, there was no sharp transition of any kind. I could feel the return of my usual condition. After the passage through the zone of hot temperatures and overstrain operation began of the landing system.

As you have already been informed, the construction of spaceship and its landing system provide for two methods: within the space cabin or by ejection and descent on parachutes. I had permission during descent to implement any of these methods. After switching in the braking motor and the change of the shipto descent trajectory I was feeling very well and decided to test the second method: at a low altitude the ejection seat separated from the spaceship and thereafter the descent was on parachute. Close-by the spaceship landed safely. This happended at 10 hours 18 min Moscow time on the 7 of August 1961.

C-9

Thus, the flight has ended successfully.

I feel very well and have not noticed or felt any changes or deviations from the normalcy in my organism, and even the doctors have found none.

The success of the flight was assured not only by the excellent making of the carrier-rocket, spaceship and its systems, but also the support of the whole Soviet people.

MAN IN SPACE:

Address of Prof. V. I. Yazdovskii.

The new stage in the mastering of the outer space was only possible due to many years-systematic work of Soviet Scientists, designers and engineers. In the first flight of Yu.A. Gagarin on spaceship "Vostok-1", the main problem was the study of weightlessness effect and of other factors on human organism during the time, required for a single orbitting of the earth. Inthe flight of Herman Stepanovich Titov the study was made of whether a man could live in space for 24 hours. In this case the investigation was made about the general state of the organism and its individual physiological systems. The efficiency was studied of the cosmonaut to control the spaceship and life support systems, and other means, providing for the safety of the flight. In space flight on "Vostok-2" the investigation was made primarily of the weight lessness effect on a man for more than 24 hours.

It should be mentioned, that the flight of comrade Titov was carried out during the period, when the radiation background in the outer space was the most suitable. This was possible due to good work of the physicists, astronomists and biologists in forecasting flares on the sun by optical observation of the solar activity and radiation reconnaissance by direct probing of the stratosphere. All the systems for providing the necessary conditions aboard the spaceship were estimated for the possibility of man-in-space flight lasting ten days. Prior to the flight a great work was carried out for perfecting the life support systems on board and careful preparation and training of the cosmonaut for the flight on "Vostok-2".

Primary results of research, conducted on spaceship "Vostok-2" made it possible to say, that the flight passed well. All the systems aboard maintained the required conditions in the space cabin.

The pressure was one atmosphere, temperature varied from 10 to 22°C and was adjusted in accordance with the spaceman's feeling of heat, percentage content of oxygen 25-27%, carbon dioxide - 0.25-0.4%, relative humidity of the air was 55-75%.

Systematic observation was conducted of the cosmonaut and his activity by means of the radiotelemetry and television. There was continuous recording of the bio-electric and mechanical activity of the heart, the rate and depth of respiration, temperature. The efficiency was judged from the radio change with the earth, precision in the implementation of flight assignment and observation of the T.V. picture.

The data of preliminary show, that on the whole the physiological functions of human organism in flight had no pathological departures. The pulse of spaceman Titov during the flight fluctuated between 80 and 100 beats per minute, which was not outside the initial level before the flight. The respiration rate was 18-22 per minute. During sleep the pulse rate of comrade Titov dropped to 54-56 beats per minute, which corresponded to background data, obtained in prolonged ground experiments not long before the flight. The shape and interval of elements in electrocardiogram of Herman Stepanovich Titov have shown no essential changes.

Inspite of the great complexity of the flight and flight assignment the efficiency of Herman Stepanovich Titov was maintained throughout the flight at a quite high level. As you know, he efficiently controlled the spaceship, made the required entries of his observations in the long-book and maintained continuous communication with the Earth.

During the space flight he carried out without any spacial difficulties all the natural functions: took food, slept, and also used the sanitary arrangement.

It should be mentioned, that prolonged weightlessness did cause some changes in the vestibular apparatus of Herman Titov, which was manifested sometimes in unpleasant sensations. However, when Herman Titov took up the initial collected posture and did not make any sharp movements of the head, these sensations almost totally disappeared. Quite possible, this was the result of some individual characteristics of Herman Stepanovich Titov. Therefore the question about the state of man in conditions of weightlessness requires further research.

After sleep these changes have considerably decreased and after switching the brake motor disappeared altogether.

After the space flight comrade Titov shows no disorders in the state of health, all the physiological functions are at a level of initial data. The efficiency fully retained.

As a result of this flight the Soviet science and specially the space biology and medicine have become enriched by a great amount of new scientific data, which are being processed at present.

The research program aboard the spaceship "VostOk-2" has been fully implemented.

In conclusion I would like once more to thank Herman Stepanovich Titov for excellent implementation of the flight program.

The next speaker is academician V. A. Kotelnikov.

Radio-communication earth - "Vostok-2".

Address of V. A. Kotelnikov:

The spaceship "Vostok-2" communicated with the earth by radio. The requirements of the radio-communication equipment were very high: it had to provide an extremely reliable communication with the cosmonaut practically at any moment of the flight, it had to be very light and compact and consume very little power.

The transmission from the spaceship to earth from great distances was implemented by means of two parallel-operating shortwave telegraph and telephone transmitters, operating with amplitude modulation. These transmitters operated through special dividing filters on a common antenna.

During flight above the USSR territory the transmission from the spaceship was conducted by means of the third ultra-short wave transmitter. The ultrashort waves assure a specially reliable communication, since their propagation does not depend on the state of ionized atmospheric layers and they are less affected by the interference from other stations. However the rounding of earth by these waves is very poor, and therefore for communications at great distances they were useless. The frequency of the ultrashort wave transmitter was 143.625 Mcps. It operated with frequency modulation in $\pm$ 30 Kcps onto a special antenna. Many stations on the USSR territory received transmissions of the spaceship. Moreover, as shown by the incoming communiques, many stations even in other countries have been receiving them. The transmission from the Earth to the spaceship was also on two waves of short wave band and on one wave of ultrashort waveband, which was used with the flight above the USSR territory. On Earth the dispatcher could switch in for transmission to spaceship radiotransmitters in various parts of USSR, depending on position at a given moment of the spaceship.

All the receivers on the spaceship were on semiconductors, their sensitivity - units of microvolts. The low-frequency characteristics of radio lines were optimum to obtain maximum legibility of speech in conditions of noise and interference; a symmetrical amplitude limitation of the input signal has been applied for this purpose in transmitters aboard.

The pilot of the spaceship could carry on transmission both from the microphones, built into the helmet of the space suit, and by means of microphones in the cabin, which he could use by removing the helmet.

For transmission by telegraph, which was provided for the case of poor audibility, there was a Morse key on board. However, it did not have to be used due to good transit of radio waves. The reception could have been conducted with earphones. In this case one ear received signals from one shortwave receiver and receiver of ultrashort waves, and in the other ear - from another receiver and additional receiver on board of broadcasting bands. The pilot could adjust the power of these signals according to his wish. If he wanted to remove the earphones, the transmission could be heard from the three dynamic loudspeakers in the cabin. This required opening the helmet.

The cabin also had an "automatic stenographer" - taperecorder. It switched on automatically every time the pilot began to speak. During the flight above the USSR territory the recording was transmitted to the Earth by means of ultrashort wave transmitter at a speed about seven times higher than that of recording to save the time. Bwsides the equipment for radio, telephone and telegraph communication, spaceship also carried a TV camera, which could transmit to Earth the picture of the pilot. Two TV cameras were used on board, one - narrow band, used on spaceship before, which transmitted the picture with clearness of a 100 lines, and the other - a new wideband system, providing clearness of a 400 lines. The second system was being tested on this flight. Both the systems transmitted 10 pictures per second. Each of the TV systems had its own transmitter, operating in ultrashort waveband. The reception was conducted at several points of the USSR territory. At the ground stations the picture was observed o the screens of special televisions and recorded on cine-film synchronously with the recording of the physiological functions of the organism. Both the systems operated quite normally during the flight and enabled to observe and record the behavior of a man in conditions of weightlessness.

Pilot-cosmonaut Herman Stepanovich Titov has highly estimated the composite radio-set , by announcing in the Red Square: "Radio-communication operated so well, that throughout the flight at each orbital point I could communicate with my beloved Motherland".

The reliable and high quality performance of radio means were obtained due to a careful preparation.

The preliminary flight experiments have made it possible to check fully the distance of communication on short-waves and ultrashort waves, to determine the effect of acoustic noise in insertion branch on the legibility of speech, to appraise the jet effect of the working motor on the passage of radio waves, to determine the possibility of simultaneous operation of receivers and transmitters during the flight, etc.

Thus, at the start of the manned flight the communication system was fully checked and in working order.

The work on radio communication with the spaceman has shown the possible communication even at great distances. When our Soviet man will fly o planets, he will also be able to speak with his Motherland and be connected with it by television.

The next speaker is the President of the International Astronautic Federation academician L. I. Sedov.

THE REALITY IS ABOVE THE FANTASY

Address of L. I. Sedov:

Not even four years have passed since the beginning of the space epoch, marked by a vigorous development of science and technique, aimed at cognizance and mastering of the Universe.

That, which was a dream and the fantasy of people, has become a reality in our days. The progressively new achievements of the Soviet Union have repeatedly shook the world: artificial earth satellites; moon shots; delivery of pennant to the moon with the Emblem of the Soviet Union; photographs of the other side of the moon; Venusian probe; launching of a series of spaceships-satellites and, finally, historic orbital flights of Yurii Gagarin and Herman Titov.

The general public and specialists of the whole world watched with admiration these investigations. The scientific and technical success was assured by the daring of conceptions, perfection of design and construction, great size and power of the space rockets and high weight of the spaceships, equipped with a composite modern apparatus for scientific experiments and for communication with the Earth. The marvelous accuracy of control systems must be specially emphasized.

Development of the Soviet space research is the center of the modern universal science, the center of interest of all the nations. The results of this work are the main scientific achievements of our time, they will serve as a basis for further progress, the memory of them will last for ever.

We, the Soviet people, are happy and glad, that the main results and the leading role in the mastering of space belongs to our Motherland.

The Soviet Union constantly and persistently fights for peaceful existence, for peace between nations, and in this noble struggle the achievements in the space science and technique are of a great help. The Soviet space research is directed towards the strengthening the peace and are peaceful scientific works.

The discoveries of the Soviet scientists belong to humanity. The main data on flight trajectories and scientific results, obtained in the Soviet investigations, are published for general information and use.

The whole world with excitement and tension watched the flights of Yu. A. Gagarin and H. S. Titov, which were announced prior to their safe completion. The people of all the countries in the world observed the course of these flights.

The scientists of the Soviet Union, just as the leading scientists of the whole world, are eager to cooperate. In conditions of peace and friendship between nations the cooperation in the sphere of science and technique is very beneficial, and this is a great boom for all the workers.

The flights of man-made space vehicles to other planets, interplanetary communication and voyages are the order of the day.

Allow me in the name of the International Federation of Astronautics to greet, congratulate and thank the leaders of the Soviet State, Soviet scientists, engineers, technicians and the courageous pilots cosmonauts Yurii Gagarin and Herman Titov.

The Soviet toilers - enthusiasts, inspired by the Party and the Government, with mighty support of the whole Soviet people have attained by their intellect and selfless labor brilliant achievements.

Dear comrade Titov, people of the whole Globe are proud of you.

"Pravda", 12 August 1961.

SECOND MANNED SPACE FLIGHT:

On the 6 of August 1961 at 9 hours Moscow time from the Soviet Cosmodrome Baikonur another successful launching was accomplished of spaceship satellite "Vostok-2", manned by the citizen of the Union of Soviet Socialist Republics, pilot - cosmonaut Major Herman Stepanovich Titov.

According to verified data, perigee distance was 183 km, and apogee distance - 244 km. The orbital inclination composed 64°56'. The initial orbital period was 88.46 minutes.

On the 7 of August 1961 at 10 hours 18 minutes Moscow time the spaceship satellite "Vostok-2" has safely landed in prescribed area on the territory of the Soviet Union in the vicinity of village Krasnyi Kut of Saratov district.

Twenty five hours and eighteen minutes lasted this historic flight, over seven hundred thousand km has flown the speceship satellite, completing over seventeen revolution around the earth.

The flight of H. S. Titov is a new step on the way to space mastering by a man. The possibility has been proved of a man's prolonged staying in the outer space.

The flights of the Soviet spaceship-satellites show, that the time is not far off, when the man will be able to penetrate far into the space, to make come true the ages-long dreams of flying to the moon, mars, venus and even more distant depths of the universe. The mankind has entered into a new epoch of mastering the secrets of nature, concealed in the depths of the cosmos.

The launching in the Soviet Union of space rockets and spaceships does not aim at setting up records and achieving external effects, astonishing the people's imagination. They are carried out in accordance with a certain program of research and mastering of space. In accordance with this program Soviet scientists, designers, engineers, technicians and workers are conducting extensive research and practical work. The exceptional achievements of the Soviet Union in rocket technique our country has placed at the service of peace and progress of mankind. The planet earth is a gigantic accumulator of energy, headed by a human mind. It depends only on man, how to order this energy, how to direct its mighty forces.

Soviet people, guided by the Communist party, has turned to the future.

With the construction of spaceships of "Vostok" type have begun and are being conducted systematic investigations for improving methods of a man's orbital insertion, his return to earth, effect of study of the space flight on human organism, elucidating possibility of a man retaining his efficiency with prolonged weightlessness; life support systems are being perfected.

The flight of the first in the world Soviet spaceman Yu. A. Gagarin has inaugurated the era of a man's mastering of space.

Less than four months later Herman Stepanovich Titov accomplished a prolonged space flight. He made a voyage approximately equal to the distance from earth to the moon and back and has safely returned to earth. This flight is another enormous step on the way of conquering the space, another historic victory of the Soviet science and technique.

Construction of spaceship "Vostok-2".

The spaceship "Vostok-2" consists of pilot's cabin, instrument compartment and braking motor compartment.

The outside of the pilot's cabin is coated with a layer of thermal protection against the effects of high temperature during descent within the dense atmospheric layers. In the shell of the cabin are three portholes and two quickly - opening hatches. The portholes are protected by heat-resistant glasses, which enable the spaceman to conduct observations both during the orbital flight and on descent trajectory. To protect the spaceman's eyes from the rays of the sun each porthole is provided with shutters, which could be closed in the case of need.

The cabin contained life support and control systems, part of radio equipment, log book, optical device for visual observation through portholes, television cameras for observing the spaceman during the flight.

The instrument compartment contains radio and control equipment and thermal control system of the spaceship.

The cabin has a special seat for the pilot-cosmonaut. This seat is a complex of systems and devices, which assure the possibility of prolonged staying of the spaceman in the cabin, and in the case of need safe separation from the spaceship and descent of the spaceman to earth. The seat is provided with devices for safe automatic separation of the pilot from the spaceship and his landing during emergency at the takeoff and insertion into orbit. The seat has a supply of oxygen and ventilating device for the comfort of the cosmonaut in the space suit. Moreover, arranged in the seat are the two-way radio set, supply of products and articles of primary necessity, which could be used by the spaceman on landing. The seat is padded with soft plastic cushions, made to fit the body.

In the case of cosmonaut's landing separately from the spaceship the parachute systems of the seat assure its stable and smooth descent onto the surface or water. In the case of descent on water the spaceman may use an inflatable dinghy, which unfurls automatically and is ready for use at the moment of coming down in water. Moreover, if the pilot comes down in water the space suit itself supports him on the surface of water in position of floating on the back; the thermal insulation and air-tightness of the suit allow staying in icy water at 0°C for 12 hours without any unpleasant sensations. The space suit is worn over a woolen underwear. The helmet has a glass "Visor", which is opened by hand and closes both by hand and automatically, if pressure or gas content of air in the cabin is above the tolerance limits. The space suit and its systems enable the cosmonaut to control the spaceship even in the case of failure of the cabin's hermetization.

Above the space suit the cosmonaut is wearing an overall of orange color. Ventilation of the space suit is by the cabin's air.

The hand control equipment the spaceman to orient the spaceship, to land in a selected area, to regulate the cabin's atmosphere, etc.

Air-conditioning and pressure-control equipment automatically maintains in the cabin normal gas composition, humidity and air pressure.

Conversation with earth could be maintained with the use of microphones, laringophon, telephone and dynamic loudspeakers, by switching on either of these by the pilots wish.

In the case of need the cosmonaut may interfere with the working of automatics, decreasing or rising the temperature, varying humidity and gas composition.

The spaceship "Vostok-2" carried a new regenerating unit, distinct from that on "Vostok-2" in the composition of blocks, chemical agents and higher perfection.

The specially prepared food (Juices, chocolade, pies, etc.) is confined in tubes, and the water is in a special tank and is taken by the spaceman through mouth-piece and hose. H. S. Titov had a reporter cine-camera "Konvas", by means of which he could take films through the portholes. There was a set of changeable objectives for the camera and a supply of color film.

The flight of the spaceship "Vostok-2" was planned for 17 revolutions around the earth. However the construction of the spaceship, reserves of food, water agents of regeneration system, power supply permit of a more prolonged flight.

After the orbital insertion the spaceship separated from the carrier-rocket. During the orbitting the equipment aboard operated in accordance with a definite program.

During flight above the USSR territory the equipment is switched in for transmission of telemetric information, orbital control and transmission of the TV picture of the pilot. Data of trajectory parameters, received by ground stations, were automatically transmitted along the communication channels into computing center, where they were processed on electronic computers. Thus, during the flight determination was made of orbital parameters and the ships movement was forecast.

The "Signal" system aboard, which continuously operates on frequency 19.995 Mcps, served for the radio bearing of the spaceship and transmission of a partial telemetric information.

During the flight the spaceman maintained radio-communication with the ground stations, transmitting information about his feeling, implementation of the flight assignment, performance of equipment, received instructions on the order of further flight.

Information, received from the spaceman on radio-telephone lines, telemetric information were processed at ground stations and concentrated at command centers of flight control. On basis of the obtained information analysis, further course was decided of the flight.

During the flight the spaceman had to carry out the following in accordance with assignment:

- to observe the performance of equipment aboard;
- test twice manual control of the spaceship;
- conduct visual observations through the cabin's portholes;
- besides the direct radio-communication with the earth to carry out during the flight above the USSR territory short-wave communications twice during an hour,
- carry out physical exercises, etc.

In the case of pilot's feeling bad or failure in performance of apparatus it was possible to bring the spaceship to earth at any moment. The resolution about descent could be taken by the spaceman independently or after consultation with the command center. The descent could have been done either by manual control of the spaceship, or with the use of automatic system.

In normal flight the descent was proposed at the start of the 19th revolution. The program provided for the use of automatic system. In this case prior to starting of brake motor there is automatic orientation of the spaceship. After operation of the brake motor at prescribed orbittal point, the spaceship changes from the orbit to descent trajectory. After the passage of high temperature zone the landing system is switched on close to earth surface and assures the landing of spaceship at low velocity.

There are two possible ways for the spaceman's landing:

- in spaceship;
- outside the spaceship: by ejection at low altitude of the seat with the spaceman and subsequent descent of the spaceman on parachute.

In this flight H. S. Titov used the second way.

Communication systems with spaceship:

In development of communication equipment with spaceship "Vostok-2" it was necessary to provide high reliability of performance both of the system as a whole, and of each block included in it.

The communication system had to provide for two-way conversations with the earth at maximum possible distances in any conditions of the flight and with the least consumption of time for getting into contact.

To ensure reliable communication the spaceship carried equipment for three two-way radio telephone lines: two on short-wave and one on ultrashort wave. The two simultaneously operating shortwave lines assured reception and transmission on various waves, each of which gets through quite well either at night or during the day.

The passage of short waves depends to a great extent on the state of ionosphere, therefore the short-wave communication is not always sure. For this reason was also used the ultra-short-wave channel, which provided for reliable communication at comparatively short distances - upto 1500-2000 km. The passage of ultrashort radio waves is practically independent of the flight altitude of the spaceship, time of day, month, year, etc., i.e. of all those factors, which determine the state of ionosphere.

Thus, the shortwave communication made it possible for the consmonaut to communicate at any time of the day at great distances - upto the opposite zone on the surface of the Globe, and the ultrashort wave communication provided for a good radio-contact with earth during the flight above the USSR territory.

The short-wave transmitters operated on a common antenna through special separating filters; in the same way the short-wave receivers operated also on a common antenna. To obtain simultaneous reception and transmission it was necessar to provide high extent of filter separation between these antennas. The ultrashort wave receivers and transmitters operated on a common antenna.

Frequency of transmitters aboard was 15.765, 20.006 and 143.625 Mcps.

The set of communication equipment on board included tape recorder with automatic start from speech signal and accelerated reading of recording on command from the earth, broad-casting receiver with smooth tuning in medium and short waves bands.

A special network of ultrashort and short wave ground stations were used on earth for communication with the spaceship. The ultrashort wave stations are equipped with special directional antennas and reproducers of accelerated recording, the short-wave ground stations used directional antennas, powerful transmitters and highly sensitive receivers. The ground centers are connected with dispatcher, maintaining communication program. He gives directions, when and which transmitter is to be use and what is to be transmitted aboard; all the information from receiving ground stations were directed to him.

Due to the great flying speed of the spaceship the questions of clear and quick communication of dispatcher with each of the many ground stations are of special significance, the slightest delay in reporting the received communique or even in transmission on board may break the contact.

Even before the flight of Yu. A. Gagarin and H. S. Titov during the launching of the spaceship with animals in March of this year complete testing was conducted of all the blocks and devices in the system of communication.

This flying experiment made it possible to check fully the distance of communication on short and ultrashort waves, to determine the effect of acoustic noise during the insertion on the legibility of speech, to determine the possibility of simultaneous operation of receivers and transmitters during the flight, etc. The electro-acoustic equipment of the pilots communication system was also tested and its stability against noise in the actual flight was checked.

Thus, at the start of the manned flights the communication system was fully checked and tested as a result of the pilot-less tests in automatic conditions.

Television equipment was also set aboard the spaceship for direct observation of the cosmonaut during the flight.

The problems of the television equipment on board the spaceship satellite "Vostok-2" were confined mainly to obtaining pictures of the spaceman characterizing his feeling, behavior, coordination of movements in carrying out various tasks.

Not less essential was the further research in conditions of the TV pictures transmission from aboard the spaceship with the object of improving television of space objects. Accordingly two TV cameras were set up aboard the spaceship-narrow and broad-band.

Both the TV systems operated independently and had their own radio-transmitters in ultrashort wave band. At the ground receiving stations the TV pictures were viewed on the screen of video-control devices and recorded on cine-films. This was simultaneous with recording of the main physiological functions-pulse and respiration rate, etc., which made possible composite comparison of various data in processing the flight material.

Provision of life support conditions on the spaceship:

The flights of spaceships "Vostok-1" and "Vostok-2" were preceded by a great amount of research in fixing the microclimate parameters of the cabin, working out ways and means of their maintenance and control during the whole time of flight. On the basis of careful analysis of investigations defined during general variations of elements in the cabin's microclimate (barometric pressure, gas composition and humidity of air, temperature of gas medium), construction of the cabin itself and its equipment the technical and physiologically - hygienic requirement of hermetic cabin were fully thought out and have justified themselves in the launching of the spaceships.

The human organism is capable of maintaining normal vital activity in conditions of environment slightly departing from normal. However, if the changes in microclimate elements of environment are considerable, the reserves of the organism become exhausted, the "equilibrium" between the organism and environment is disturbed, disorders of individual physiological systems and of the vital activity as a whole appear. Any departure in microclimate elements of environment from normal parameters, causes in the organism an additional physiological strain, deteriorated the human endurance of overstrain, weightlessness, transitions from overstrain to weightlessness and vice-versa, etc.

To maintain the basic parameters of the cabin's microclimate close to normal the use was made on spaceship "Vostok-2" of air-regenerating system, which provided, on one hand, absorption of carbon dioxide and moisture, exceded by a man, and on the other emanation of a certain quantity of oxygen, required for breathing.

The amount of oxygen, emanated by the system, was adjusted (within certain limits) by the need of the spaceman himself. Deviations from the present content of oxygen, carbon dioxide and water vapors in the atmosphere of space cabin were recorded by special sensitive elements, the signal of which were perceived by the automatic regulator controlling the rate of corresponding reactions in regenerator.

The automatic control of regenerating unit was duplicated by manual control, which enabled the spaceman in the case of necessity to control the operation of the unit, making up the required composition of the cabin's atmosphere, humidity and temperature.

Special automatic thermal control system maintained the required temperature in the space cabin. Development of this system involved overcoming a number of difficulties, specified, on one hand, by the variability of heat exuded by a man and operating equipment per unit time, and on the other - radiation heating of cabin from the sun.

The automatic thermal control system consisted of two ducts air - open into space cabin and fluid - leading to a special heat radiator in the instrument compartment of the cabin. Both these ducts joined in the air-fluid heat exchanger in the space cubin. The spaceman could independently fix the temperature in the cabin within the limits from +10 to +25°C, which was hence maintained automatically.

All the parameters, characterizing performance of regeneration system and the atmosphere of space cabin, were watched by the spaceman in devices on the control board and transmitted to earth by radio-telemetry.

Numerous experiments, conducted in ground laboratories, have shown, that the air conditioning and regenerating system reliably assures maintenance within the required limits of pressure, temperature, humidity and gas content in the cabin's atmosphere.

Physiological specificity of weightlessness:

The main difference of the second space flight from the first consisted in the fact, that it was longer and was implemented in accordance with a more extensive program of research.

It is well known, that one of the factors, which a man encounters during space flight is the weightlessness. Whereas until recently very little was known about its effect on the organism. Cases of partial and brief weightlessness, which are known to man in surface conditions, did not allow to make some scientifically based prognoses regarding the space flight. There were controversial opinions regarding the effect of prolonged weightlessness on the orientation of a man in space, coordination of his movements, function of cardio-vascular and digestive systems and psychic state.

All this persistently required an all round study of this important problem. Moreover, primarily it was necessary to clarify the nature of the weightlessness effect on the vitally important functions of the organism-blood circulation and respiration, i.e. to establish how dangerous to a man's life is the state of weightlessness. Not less important also was the study of the possibility of normal vital activity of the spaceman in flight, his efficiency, capacity to take food, sleep, etc.

The resolution of these questions was extremely difficult. This was due to the fact, that the construction of special stands for reproducing weightlessness in surface conditions is a technically extremely complex problem. Actually, for a man in order to cease feeling his own weight, it is necessary to create conditions, in which there will be no stimulation of receptory apparatus (nerve ends) from which there is a constant flow of impulses into the central nervous system informing the man of the body position in space and of the position of various body parts.

As we know, the orientation of a man in space and exact coordination of his movements happens to be possible due to clear functioning of the three systems; vestibular apparatus, organ of vision and receptory apparatus of the skin, muscles, tendons, joints and ligaments.

The vestibular apparatus is located in the labyrinth within the pyramid of the temporal bone. It consists of three semicircular canals, located within three planes, and otolithic organ. The semicircular canals perceive the angular accelerations and the otolith organ reacts mainly to gravity changes. The otolith is located on the junction of the semicircular canals and is a hollow, the bottom of which is lined with sensitive nerve cells. The cells have the finest filaments and lying on these in a jelly-like mass are small crystals of calcium carbonate and calcium phosphate salts. - otoliths. With the changing position of head or of gravity the pressure of otoliths on nerve cells changes, and therefore the stimulation of the latter also changes. Nervous impulses from otolith are transferred into the central nervous system, and on basis of the incoming information the correct orientation of the body in space is implemented by means of certain muscular groups.

All the above systems (vestibular apparatus, vision, etc.) supplement each other reciprocally.

It should be added, that the vestibular apparatus is closely connected with the vegetative nervous system, which regulates such automatic functions, as digestion, cardac activity, vascular tonus, sweating, etc. Hence changes in the function of vestibular apparatus can cause considerable deviations in the functions of the above systems.

The first special tests in the study of weightlessness effect on a human organism were conducted on a surface stand, which permitted to create weightlessness lasting 1 - 2 seconds. The results of these tests, however, could not satisfy the investigators, since the effect of weightlessness was too brief. Very interesting was the attempt to imitate the state of weightlessness by submerging a man in a special suit into fluid of specific gravity equal to that of a man. These tests enabled to get an idea about the functions of organism in conditions, approximating the state of weightlessness, when the activity of a part of nervous receptors was eliminated.

An essential step forward in the study of weightlessness were the experiments on planes. During the flight of a high-speed plane in parabola the developing centrifugal force balances the gravity. In these conditions it is possible to obtain weightlessness lasting up to 40 - 50 seconds.

The experiments on planes permitted to get answers to the questions on subjective endurability of this unusual state, on reactions of cardio-vascular system, orientation in space, coordination of movements, etc.

In this case it was fixed, that there are no appreciable changes in the function of cardio-vascular and respiratory systems; there is no departure from normal in the rate and rhythm of pulse and respiration, in arterial pressure, electrocardiogram. There is no noticeable effect of weightlessness on hearing or sight. Orientation in space and coordination of movements with open eyes also do not show any appreciable changes. This is clear from the fact, that undergoing the test could execute quite suitable movements, such as, for instance, recording in log book, Morse key operation, etc. As regards the subjective sensations, these were differing. Some felt excellent in conditions of weightlessness, others noticed a number of unpleasant feelings and sensations. These were expressed in nauses, vertigo, loss of orientation, sensation of rotation, etc. True, in a number of persons with repeated flights developed adaptability, which proves possible training for weightlessness. It is a very important fact.

Thus, the plane tests have helped to clear a lot. However, all this could be taken as true only for a comparatively short time of the weightlessness effect. At the same time it was clear that the time factor will be of significance. Many important questions could not even be put up for resolutions in experiments on the planes. Therefore, the next step in the study of this unique factor of space flight was the research on various types of animals- mice, rats, dogs, - placed on rockets, and later on satellites. In some experiments the duration of animals being in conditions of weightlessness was over 24 hours and nevertheless no adverse effect was noticed on physiological functions or vital activity of the animals. Positive results of these experiments made it possible to come to conclusion, that weightlessness, lasting upto 24 hours will not be dangerous for life and health of man.

On the 12th of April 1961 Yu. A. Gagarin accomplished a space flight. After entering an orbit he remained in the state of weightlessness for about an hour. He did not noticed any unpleasant consequences. Without any difficulty he took food, done writing, conducted the required observations. Those were very important observations of the first in the world cosmonaut.

But space flights may continue weeks, months and years. Further study was required of this important problem, as of the whole life cycle of a man in prolonged weightlessness.

The extensive program of medical investigations on spaceship "Vestok-2" included study of diurnal life cycle of a man in conditions of spaceship and efficiency investigation of the cosmonaut in prolonged weightlessness.

Various methods for obtaining information were used for the implementation of this program. The information was transmitted by radio to earth and processed. The use was not only of subjective sensations and feelings, transmitted by the cosmonaut from aboard the spaceship, but also of objective indices. recorded automatically.

In the first case the information was coming through the system of two-way radio-telephone equipment, and also from transmissions of summaries in a certain form. In the second, television and telemetry were used. At present all this information is being studied and processed.

Ensuring radiation safety:

On spaceships-satellites, preceding flights of Yu. A. Gagarin and G. S. Titov, an extensive program was conducted of biological experiments. These permitted to come to the conclusion, that a manned flight in similar conditions is possible and not dangerous for the health. In particular, this flight is not dangerous in respect of radiology. However, not all the questions, connected with the possible biological effect of radiation, can be considered as solved. Special in this respect required the solar flares. Some of these are associated with sharply increased intensity of cosmic radiation, changes in its qualitative and quantitative composition and could be dangerous to a man aboard the spaceship.

At present the regularity in the appearance of these flares is not sufficiently well known, and to foresee them is a difficult problem.

To ensure the radiation safety of G. S. Titov's flight certain measures were taken for observing the solar activity and direct measuring of cosmic radiation in the upper atmospheric layers.

During the period, preceding the launching, and throughout the whole flight an extensive network of astronomical observatories conducted regular observations of the sun with the use of special methods, which permitted to forecast with high probability increase in the solar activity and flares. At the same time in various parts of the Soviet Union, specially in polar latitudes, systematic launching was conducted of balloons, directly recording the intensity of cosmic radiation in stratosphere. All the information obtained by these methods was immediately processed and quickly communicated to flight control. The decisions on the start of flight and its subsequent program were taken with an estimate of this information.

During the period immediately preceding to the launching of spaceship "Vostok-2" and also during the whole flight the solar activity was within the normal limits. Intensity of the cosmic radiation in the stratosphere, measured by means of cosmic radiation balloons, was normal throughout. In respect of radiology the flight was in suitable conditions.

How the flight was passing:

It may be assumed, that the specific effect of space flight factors actually "begins" from the moment of stepping into the cabin and the shutting of the hatch. The spaceman was left alone, he is isolated. True, in this case the isolation is incomplete, as G. S. Titov continuously communicated with the command center of flight control. At this time there could be noticed insignificant variations in the respiration rate and acceleration of heart beats upto 90-106 per minute. One minute before the start pulse rate was upto 120/minute. Undoubtedly, these changes were due to emotion.

As we know, from the moment of the rocket's takeoff the organism is subjected to gradually increasing effect of overstrain, which may cause noticeable physiological changes in a number of organs and systems. It should be mentioned, that both in Yu. A. Gagarin and G. S. Titov, according to subjective and objective data, the propulsion period prior to orbital insertion passed without any unpleasant consequences.

G. S. Titov at the press- conference on the 11th of August remarked: "Overstrain, noise and vibration in the insertion branch have endured well and without unpleasnat sensations. During this period I conducted observations through the portholes and of instruments, maintained two way radio-communication with the earth". True, it should be mentioned, that inspite of such good general subjective state of the cosmonaut, there was some quickening of the pulse, which was upto 118-134/minute.

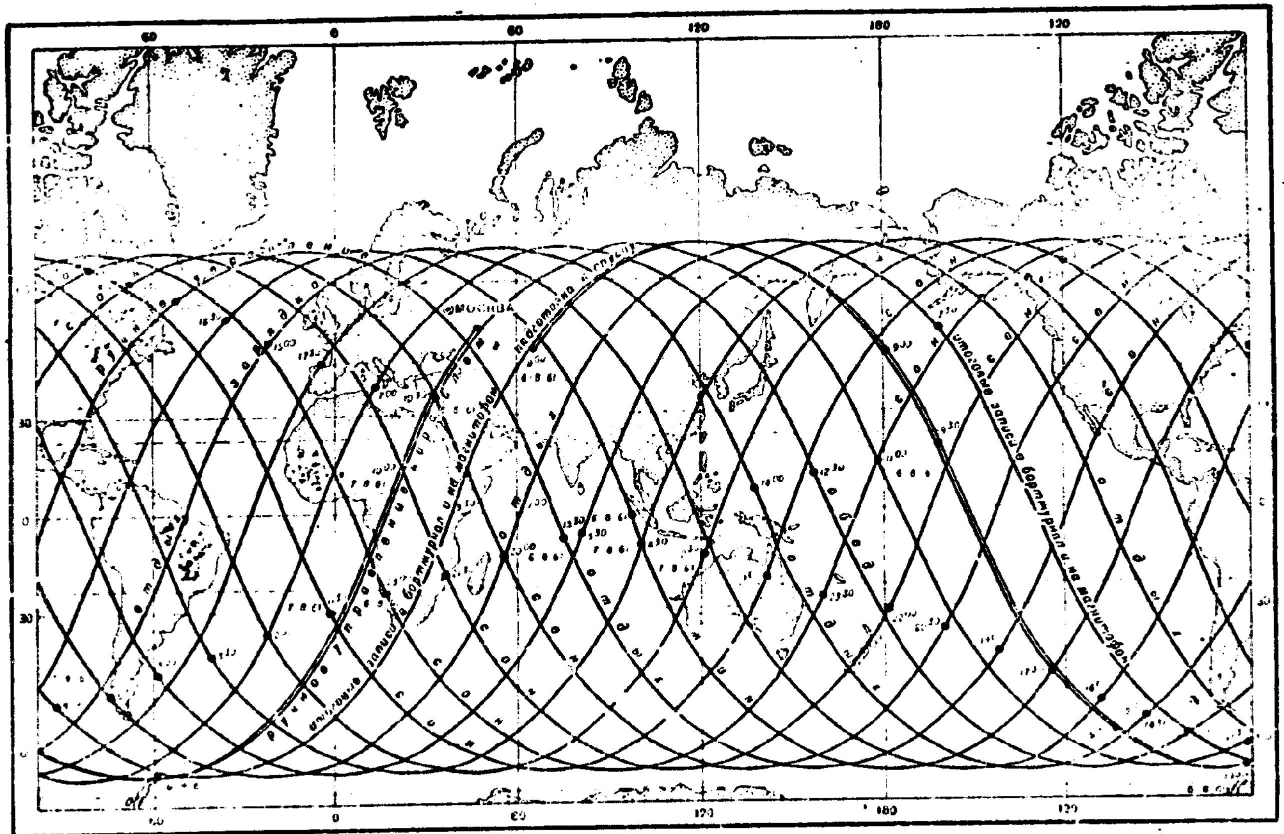

Figure 3: Air route of spaceship "Vostok-2".

The changes marked in heart beats and respiration were specified by the effect of the whole complex of flight factors (noise, vibrations, overstrain), including the natural for this flight emotional tension.

However, these changes were not outside the limits of those, observed in G. S. Titov during training in the preparation period, for instance, on centrifuge.

With the orbittal insertion and cutoff of engines the effect of noise, vibrations and overstrain has ceased: now there was weightlessness. The first impression, according to G. S. Titov, was original: it seemed to him, that he was flying upside down. But soon, after a few seconds, this sensation disappeared.

The spaceman got in contact with earth, transmitted communique on his feeling and performance of equipment, conducted observations through the portholes.

When the spaceship entered into the shadow of the earth, the spaceman observed its surface.

In accordanco with the flight program at 10 hours Moscow time G. S. Titov switched on the manual control of the spaceship. He conducted manual orientation of the spaceship and a number of other manueveres, required for the scientific measurements. In his conclusion the manual control permits to carry out fully all the required maneuvers, control equipment operated exactly, without any deviations. The second time G. S. Titov switched on the manual control on the seventh revolution.

At the start of the second revolution the spaceman began cine-filming. The filming and observations were conducted also afterward for short periods throughout the flight. The whole supply of cine-film was used up. The results of this filming are of definite scientific interest.

In the observations of earth surface it is possible to distinguish rivers, mountains, fields. The clouds were clearly visible. They were easily distinguished from the snow by the shadow they threw on the surface of the earth. The earth's horizon is surrounded by a pale-blue halo. When the spaceship came out from the earth's shadow, the horizon was seen in the shape of a bright orange sickle.

In accordance with the flight program G. S. Titov maintained communication on short and ultrashort waves, received radio-programs by means of broadcasting receiver, made entries in log-book and on tape recorder.

Throughout the flight there was a reliable twoway communication of the spaceman with the earth.

During the flight the cosmonaut transmitted greetings to Moscovites, peoples of the Soviet Union, Europe, Asia, Africa North and South Americas, Australia.

At the third revolution the spaceman lunched, and on the sixth,dined, done exercises, etc.

The weightlessness did not prevent the spaceman from carrying out also all the natural needs, take food, use the sanitary system and even sleep. True, the sleep, specially at the beginning was restless, and the appetite low. It may imagined, that the low appetite and the slight vertigo and nausea were due to unusual irritation of the vestibular apparatus under the effect of weightlessness. It is significant to mention, that the pointed out changes in the vestibular apparatus almost totally disappeared as soon as the spaceman took up the initial collected attitude and did not make any sharp movements with the head. These indications have become to a considerable extent reduced after sleep and completely disappeared at the start of overstrain effect during the return of spaceship to earth.

It should be pointed out, that during the orbitting, when the spaceman was awaken, the pulse, rate varied from 80 to 100/minute, which was slightly higher, than the initial indices and during the sleep decreased to 54-56 and corresponded to ground conditions, The shape and elements of electrocardiogram throughout the orbitting did not show any significant changes.

The prolonged stay of G. S. Titov in conditions of weightlessness has passed well and did not cause any pathological disorders. Some changes were only marked in vestibular apparatus, which did not effect the efficiency of the spaceman. In the fothcoming investigations it will be necessary to elucidate, whether the reactions, noticed by the spaceman in vestibular apparatus are the result of the higher individual sensitivity or will frequently accompany spaceman in conditions of weightlessness.

In the latter case the necessity may arise for creating on the spaceship of artificial weight, which could be implemented by special technical means.

All the life support systems on the spaceship "Vostok-2" operated normally. There were no disturbances in the composition of atmosphere, pressure and heat exchange. In the cabin's temperature the spaceman adjusted himself. According to received data it fluctuated from 10 to 25°C. The humidity was 50-70%.

In accordance with the flight program on the 7th of August 1961 at calculated time the automatic orientation system and the automatics for descent and landing of the spaceship in prescribed area were switched in. After the exit of the spaceship from the earth's shadow there was the search and orientation of the spaceship on the sun. Hence in accordance with a special program preparation began of equipment for starting the brake motor and, finally, the brake motor was started; the spaceship changed to descent trajectory. G. S. Titov transmitted to earth information about the passage of all commands and communiques on the flight.

Having completed seventeen revolution around the earth, the spaceship "Vostok-2" and pilot cosmonaut G. S. Titov landed in prescribed area. This happened at 10 hours 18 minutes Moscow time in the area of Krasnyi Kut village of Saratov district.

According to all the data available at present, and on the basis of subjective sensations of G. S. Titov, his efficiency was retained throughout the flight at quite a high level.

From the expressions of G. S. Titov and available data, transition from weightlessness to overstrain at the moment of the ship's deceleration was quite smooth and did not involve any unpleasant consequences and functional disorders. The descent was quite successful. The spaceman felt throughout very well and his mood was cheerful. No pathological aftermath has been recorded. Thus, the main and most important result of G.S. Titov's flight on spaceship "Vostok-2" is the proof, that efficiency of a man during a 25 hour space flight is fully retained.

During the after-flight examination no departure what so ever were found in the health of the spaceman.

G. S. Titov has accomplished the greatest feat. This feat reflects the new enormous achievements of the Soviet Union, our science and technique, the whole national economy, the great advantages of the socialist order foremost in the world.

The scientists, designers, engineers, technicians and workers, whose selfless labor made possible launching of spaceship "Vostok-2", have dedicated this flight to the XXII Convention of the Communist Party of the Soviet Union.

The achievements in space research the Soviet Union places at the service of peace, scientific progress, for the good of the people of our planet.

"Pravda", 8 September 1961.

TASS COMMUNIQUE ON THE LAUNCHING OF SPACESHIP SATELLITE "VOSTOK-3".

On the 11th of August 1962 at 11 hours 30 min Moscow time the Soviet Union has placed into earth orbit spaceship-satellite "Vostok-3" manned by pilot cosmonaut Major comrade Nikolaev Andriyan Grigorevich.

The object of the flight:

- obtaining additional data on the effect of space flight on a human organism;
- Investigation of the efficiency of a man in conditions of weightlessness;
- carrying out by a man of a certain amount of research in conditions of space flight;
- further improvement of the spaceship's systems, means of communication, control and landing.

The spaceship satellite "Vostok-3" was inserted into orbit, close to calculated one. According to preliminary data, orbittal period of the spaceship is 88.5 minutes, perigee and apogee distances are 183 and 251 km respectively, orbittal inclination about 65°. A two-way radio-communication is continuously maintained with spaceship "Vostok-3".

According to communications of pilot cosmonaut comrade Nikolaev and also objective data, obtained by telemetry and television, he satisfactorily endured the period of orbital insertion and transition to weightlessness. Comrade Nikolaev feels quite well.

Comrade Nikolaev is carrying on his transmissions on frequencies 20.006 and 143.625 megacycles per second. The spaceship carried also transmitter "Signal", operating on frequency 19.995 Mcps.

All systems aboard the spaceship function normally. Information about the flight will be transmitted by all the radio-stations of the Soviet Union.

"Pravda", 11 August 1962. (Extra edition).

STATEMENT OF A. G. NIKOLAEV PRIOR TO TAKEOFF:

Dear comrades: May friends:

Quite recently I was seeing off my friends Y. Gagarin and G. Titov into first space journeys, and today the great honor of accomplishing another space flight has come to me.

I am sincerely grateful to our own Lenin's Central Committee and the Soviet Government for their trust and shall apply all my powers and knowledge to implement worthily this noble assignment.

Photo: An[illegible] Gri[illegible]r'evich [illegible]ev.

The first [illegible] fli[illegible]hts [illegible] [illegible] [illegible] admired [illegible] filled [illegible] [illegible] [illegible] [illegible] achieve-ments of the Soviet [illegible], attained [illegible] [illegible] the leadership of the Com[illegible] Party.

[illegible]

[illegible]

[illegible]

[illegible]

Pages from biography:

Andriyan Grigor'evich Nikolaev was born on the 5th September 1929 in Shorshely village of Mariinsko-Posadskii area of Chuvash ASSR in the family of poor peasant. In nationality - chuvash.

In 1944 A. G. Nikolaev finished 7 classes of incomplete middle school in Shorshely village. The same year he entered, and in 1947 finished Mariinsko-Posadskii forestry school and received forester diploma in forestry. From December 1947 till April 1950 worked as supervisor in timber industry.

In 1950 called for National Service and directed into millitary avioschool. Since 1955, air-force pilot.

In 1961 granted an order of the Red Star. Since 1957 A. G. Nikolaev has been a member of the Communist Party of the Soviet Union. He is a bachelor.

His father - Grigorii Nikolaevich died in 1944, mother - Anna Alekseevna was born in 1900. Brother - Ivan Grigor'evich, born in 1927, works in Kirskii timber industry of Altyrskii area of Chuvash ASSR. Brother - Petr Grigor'evich, born in 1936, is a driver in collective farm and lives in Shorshely village. Sister - Zinaida Grigor'evna, born in 1932, is a nurse at blood transfusion center in Cheboksar. city.

"Pravda", 11th August 1962. (Special edition).

TASS COMMUNIQUE FROM ABOARD THE SPACESHIP:

11 hours 24 minutes.

Pilot cosmonaut Major Nikolaev has communicated from spaceship above the Soviet Union territory at 11 hours 45 minutes Moscow time: "Feel well. Everything normal aboard. The Earth is clearly seen through portholes. Cosmonaut Nikolaev.

13 hours 08 min.

The flight of spaceship satellite "Vostok-3" proceeding normally. All the systems and instruments perform steadily. Thermal control and air-conditioning systems maintain temperature, pressure and humidity within the set limits. Objective data, received by telemetry, confirm, that comrade Nikolaev have stood well the orbital insertion and initial orbital period. TV picture of the spaceman and communications transmitted to earth indicate, that he is feeling well. Radio-telephone communication is maintained with the spaceman by means of a network of ground stations. At 13 hours 08 min Moscow time comrade Nikolaev greeted from aboard the spaceship people of the Soviet Union.

On the third revolution.

The flight of spaceship "Vostok-3" continues successfully. Major Nikolaev, while flying at the start of second revolution above Africa, transmitted greeting to the freedom loving people living in this continent. On the third revolution he reported to Central Committee of the Communist Party of the Soviet Union and the Soviet Government the successful flight. Flying above Europe he transmitted greeting to the true friends of his motherland - people of Socialist countries.

The fourth revolution:

Spaceship satellite "Vostok-3" with pilot cosmonaut Maj. Nikolaev continues its flight. During the 6 hours spaceship "Vostok-3" has orbitted the earth four times, covering distance of over 160 thousand km. Comrade Nikolaev has reported, that he successfully carries out the planned research program. His condition is excellent. Temperature in the cabin - 25°C. Pressure and humidity normal. All the systems of the spaceship operate well.

After implementing the first part of research program, during which he controlled the spaceship himself, Comrade Nikolaev had his lunch and rested for an hour.

At the start of the fourth revolution there was a routine TV transmission from aboard the spaceship.

Above South America.

The spaceship satellite "Vostok-3" successfully continues its flight. Maj. Nikolaev reported that everything is in order; the assigned program is being fully implemented.

While flying above the South America Maj. Nikolaev transmitted greeting to the people of Latin America.

The spaceman informs, that he can clearly see mountains, highways and rivers.

All the equipment of the spaceship operates unfailingly; the pilot feels well. Temperature in the space cabin is 24°C.

19 hours.

At 19 hours Moscow time on the 11th of August the spaceship satellite "Vostok-3" has completed 5 revolutions around the earth having covered during this time a distance of over 200 thous. km.

The condition of the spaceman is excellent, pulse rate varies between 78 and 92, respiration rate - 12-20.

In accordance with the flight program Comrade Nikolaev freed himself from harness, came out of the seat and freely moved around the cabin. There were no disorders in the function of vestibular apparatus. The spaceman informed, that his appetite is excellent.

As a result of the processing of information, regularly coming to coordination center the orbit of the spaceship has been verified . At 19 hours on the 11th of August orbital elements of the spaceship "Vostok-3" were as follows: orbital period 88.32 min., perigee and apogee distances - 180 and 234 km respectively, orbittal inclination - 64°59'.

The reception is continuing of the telemetric information, which indicates faultless functioning of the instruments and units aboard. The present temperature, pressure and humidity are maintained in the cabin. Continuous two-way radio-communication is being maintained with "Vostok-3" and during the flight of the spaceship above the Soviet Union TV picture of the spaceman is received. Further information on the movement of spaceship and condition of Maj. A. G. Nikolaev will be regularly transmitted from central radio.

22 hours.

At 22 hours Moscow time on the 11th of August spaceship satellite "Vostok-3" with pilot cosmonaut Maj. Nikolaev A. G. aboard has completed over seven revolutions around the earth, covering during this time a distance of about 300 thous. km.

Flying above various areas of the Globe, Maj. Nikolaev transmitted greeting to the people of our motherland and socialist countries, as well as to the people of Africa, Latin America and the USA.

During the ten and a half hours in space pilot cosmonaut Nikolaev carried out various and composite tasks: regular observations were conducted of the systems and units aboard, correction and adjustment was implemented of the individual units of equipment on directions from earth, visual observation conducted through the portholes. The spaceman clearly saw islands, rivers, lakes, cities and populated centers.

Regular communication was maintained with the spaceship by radio and television. At 20 hours 40 minutes the spaceship satellite passed above Moscow. At this time the TV picture of the spaceman was transmitted in Central television directly from aboard the spaceship. All the results of his observations Comrade Nikolaev recorded in the log book. He took food three times breakfast at 12.30, lunch at 15 hours and dinner at 21 hours 50 min. For the first time natural products were used for the pilot's meals.

In accordance with the flight program the spaceman twice used the manual control of the spaceship. The orientation of the spaceship in this case was quite normal.

To test the efficiency in conditions of weightlessness the spaceman has left his seat twice and moved around the cabin. According to communication of Comrade Nikolaev the efficiency is fully retained in these conditions.

According to reports of the spaceman and telemetry data, conditions in the space cabin remained normal throughout. At the end of the seventh revolution the temperature was 23°C, pressure 1.1 atm., humidity - 70%. The spaceman Comrade Nikolaev feels well.

After dinner at 22 hours Comrade Nikolaev in accordance with the flight program laid down to sleep.

Further communications on the flight of spaceship satellite "Vostok-3" will be transmitted in the morning on the 12th August.

"Pravda", 12th August 1962.

TASS COMMUNIQUE - GLAD NEWS FROM SPACE:

12th August, 5 hours.

The spaceship satellite "Vostok-3" continues its flight. At 5 hours Moscow time on the 12th of August it completed over 12 revolutions around the earth, covering a distance of over half a million km.

From 22 hours on the 11th of August till 5 hours on the 12th of August Comrade Nikolaev in accordance with the flight program has slept. During this time the performance and control of the instruments were automatic. Simultaneously the condition was being checked of the sleeping spaceman.

At 5 hours after awakening comrade Nikolaev communicated by radio with the earth and reported, that he is feeling well, everything is in order on board and that he has started implementation of research program, marked for the second day. The communication with the spaceman continues.

7 hours.

At 7 hours Moscow time on the 12th of August the spaceship satellite "Vostok-3" has completed over 13 revolutions around the earth and successfully continues its flight. All the systems aboard operate normally. Temperature in the cabin is 18°C.

The processing of telemetric data have shown, that the sleep of comrade Nikolaev was quiet. From 22 hours on 11th of August spaceman's pulse was 60-65, respiration even and deep, Soon after awaking the pulse quickened to 80-90. Having done some exercises the spaceman began his breakfast.

Comrade Nikolaev feels perfectly well. He clearly, calmly and concisely reports on performance of the spaceship units and implementation of the assigned research program.

10 hours.

At 10 hours Moscow time on the 12 of August spaceship-satellite "Vestok-3" manned by Maj. Nikolaev has more than 15 times orbitted the Globe. During the 22 and a half hours of space flight the spaceship satellite covered a distance of 630 thousand km. The flight is quite normal, fully in accordance with the planned program. Temperature in the cabin, pressure and humidity are normal.

The spaceman Nikolaev is cheerful and energetic and continues to implement the marked out program. The time from 7 to 10 hours on the 12th August was assigned by the flight program mainly to various researches, physiological and psychological tests. All the tasks of the program are successfully implemented by Comrade Nikolaev. According to data of coordination center orbital parameters of "Vostok-3" at 10 hours on the 12th of August were as follows; orbital period - 88.28 min., apogee and perigee distances 23; and 179 km respectively. The objective medical data indicate good physical condition of the spaceman. His mood is cheerful. In conversations with earth Comrade Nikolaev is interested in the latest news. Specially he asked to be informed of the results of the final match for SSST Cup in football, which took place yesterday in Moscow.

The spaceman congratulated the team "Shakhter" with victory. The flight of spaceship "Vostok-3" is continuing.

"Pravda", 12th August 1962 (Special edition).

TASS COMMUNIQUE ON THE LAUNCHING OF SPACESHIP SATELLITE "VOSTOK-4":

On the 12th of August 1962, at 11 hours 02 min. Moscow time the Soviet Union has placed into earth orbit spaceship "Vostok-4".

The "Vostok-4" is manned by a citizen of the Soviet Union pilot cosmonaut Lieutenant Colonel Comrade Popovich Pavel Romanovich.

In accordance with assignment the launching of the spaceship "Vostok-4" was carried out during the orbitting of spaceship "Vostok-3", launched in the Soviet Union yesterday, 11th August 1962. At present orbitting simultaneously are two Soviet spaceships - "Vostok-3" and "Vostok-4", manned by citizens of the

Soviet Union Comrades Nikolaev A.G. and Popovich P.R.

The aim of inserting into close orbits of two spaceships is the obtaining of test data on the possibility of establishing direct communication between the two spaceships, coordinated actions of pilot-cosmonauts, checking the effect of similar conditions of space flight on human organism.

According to preliminary data, the orbit of the spaceship "Vostok-4" is close to calculate . The initial orbital period is 88.5 min., the perigee and apogee distances are 180 and 254 km. respectively, orbital inclination about 65°. The spaceships are near each other and there is a two-way radio-communication between them.

The ground stations have established a two-way radio communication with "Vostok-4", which transmitts on frequencies 20.006 and 143.990 Mcps.

The spaceship also carries transmitter "Signal" operating on frequency 19.990 Mcps.

The pilot cosmonauts Comrades Nikolaev and Popovich both feel well.

All the systems of spaceships "Vostok-3" and "Vostok-4" operate normally. For the first time in accordance with the plan of research there is a joint group flight in space of two Soviet spaceships "Vostok-3" and "Vostok-4", manned by Soviet citizen Comrades Nikolaev A.G. and Popovich P.R.

"Pravda", 12th August 1962 (Special Edition).

STATEMENT OF P.R. POPOVICH BEFORE TAKEOFF:

My dear friends and Comrades! Cnly yesterday was placed into orbit spaceship "Vostok-3", manned by Andriyan Grigor'evivh Nikolaev.

Today another Soviet spaceship is ready to takeoff. And I have been entrusted with the place of pilot in this spaceship.

I'am taking off into space flight with great pride for our Soviet people, who are paving the way for mankind into communist future.

Let this new fourth journey to the stars be the next contribution of our people into the cause of further mastering of space with peaceful aims.

My "celestial brothers" have marked the first space routes. Now, following these routes, flies "Vostok-3", and I depart to follow him, in order to continue the conquest of the Universe.

I'am ready for the flight and shall conduct in a way, befitting a communist.

Good-bye until we meet again, dear friends!

Pages from biography:

Pavel Romanovich Popovich was born on the 5th of October 1930 in Uzin village of Kiev region in the family of a laborer. In nationality - Ukrainian.

Have attended primary, and then trade school in Belaya Tserkov. Later on joined the Magnitogorsk Industrial Technical School. Finished it in 1951 with a diploma of builder-mechanic.

During National service has b en placed into air-force school. After finishing it served in Air-Force. Now he is an Air-Force Pilot.

In March 1949 admitted as a candidate for pilot cosmonaut. Member of the CPSU since June 1957.

Photo: Pavel Romanovich Popovich.

In 1961 was awarded an order of the Red Star.

The cosmonaut is married. His wife - Vasil'eva (in marriage Popovich) Maria Lavrentevna was born in 1931. In profession a pilot, now works as a computer technician. His daughter Natasha is six years old.

Father - Popovich Roman Porfir'evic, born in 1905, works in Uzine of Kiev region. Mother Popovich Feodos'ya Kac'yanovna, born in 1903, is a housewife. He has two sisters - Maria, born in 1927, and Nadezhda, born in 1944, and two brothers - Nikolai, born in 1946, Petr, born in 1937, leiutenant in the Army.

TASS COMMUNIQUE ON THE GROUP FLIGHT:

14 hours.

The group flight of spaceship "Vostok-3" and "Vostok-4" continues. At 14 hours Moscow time on the 12th of August the two spaceships in joint flight have completed two revolutions around the earth. The spaceship "Vostok-3" has orbitted the Globe 18 times since the takeoff, covering over 740 thousand km.

Comrades Nikolaev and Popovich report, that everything is going well, they both feel excellently, instruments and systems of spaceships operate unfailingly. A steady two-way radio-communication is being maintained between the two spaceships, which are at close distance to each other.

The spaceman Maj. Nikolaev has communicated that, while controlling his spaceship in accordance with assignment, he observed through portholes the flight of spaceship satellite "Vostok-4".

At 12 hours 34 min. Moscow time spaceman comrade Popovich transmitted: "Moscow, Kremlin, to Central Committee of CPSU, Soviet Government, Reporting. The flight of spaceship "Vostok-4" proceeds normally. Feeling well. Very well. Very proud of the successes of our technique. Greetings to the whole Soviet People, Soviet Pilot cosmonaut Popovich".
"Pravda", 12th August 1962 (Special Edition).

TASS COMMUNIQUE, GROUP FLIGHT CONTINUES:

14 hours 30 minutes - 15 hours 45 minutes.

The flight of spaceships satellites "Vostok-3" and "Vostok-4" continues successfully. All the systems aboard the spaceships operate normally. Conditions in space cabins (temperature, air composition , humidity) are maintained within the set limits.

The spaceman Comrade Nikolaev and Popovich are conducting the planned program of research. At 14 hours 30 minutes Moscow time they took their lunch and for an hour rested; the spacemen feel fine, pulse rate in both is about 70.

TV pictures of the spaceman are transmitted directly from the spaceships to the earth and are transmitted by the Central Television and Intervision.

18 hours 30 minutes.

At 18 hours 30 minutes Moscow time on the 12th of August spaceships satellites "Vostok-3" and "Vostok-4" were in group flight for seven and a half hours, having orbitted the Globe five times, At this time "Vostok-3" with spaceman Nikolaev has completed 21 revolutions around the earth, covering about 850 thousand km.

The Soviet spacemen are continuing their research in accordance with the object of launching. Telemetric information on performance of the units and systems of spaceships and the reading of instruments are regularly incoming from "Vostok-3" and "Vostok-4" to ground centers and are immediately transmitted to Coordination Center for processing.

The spacemen comrades Popovich and Nikolaev freed themselves on the 12th of August from harness, left their seats and carried out the tasks , provided for by the flight program.

Both the spacemen are in excellent condition. Their pulse is even - 65-70. Temperature in the cabin of "Vostok-3" 17°C, and in that of " Vostok-4 " 24°C, pressure and humidity of air normal. The spacemen continue to maintain a two-way radio communication with each other.

22 hours.

At 22 hours Moscow time on the 12th of August the spaceship "Vostok-3" completed over 24 revolutions around the earth, having flown in space about 970 thousand km. The spaceship "Vostok-4" orbitted the earth more than eight times, covering over 300 thousand km.

The group space flight of comrades Nikolaev and Popovich on spaceships "Vostok-3" and "Vostok-4" is continuing.

Orbital parameters of spaceships "Vostok-3" and "Vostok-4" at 21 hours on the 12th of August were respectively.

Orbital period - 88.2 and 88.3 minutes;

apogee distance - 227.6 and 234.8 km;

perigee distance - 176.7 and 177.9 km;

orbital inclination - $64^{\circ}59'$ and $64^{\circ}57'$.

Comrades Nikolaev and Popovich have fully implemented the reaearch program, set for the 12th of August.

The spacemen feel fine. Comrade Popovich had no ill effects from overstrain during the orbital insertion, he lost none of his efficiency and continued to pmaintained communication with the earth. In conditions of prolonged space flight he also feels quite well as much as Comrade Nikolaev does. The spacemen steadily maintain communication with the earth and with each other at a set time.

Both the spacemen rigidly maintain the time-table set for their space flight. On the 12th of August Nikolaev and Popovich lunched and dined with appetite.

The objective data confirm the excellent condition of the spacemen. Pulse rate of Comrade Nikolaev is within 64-72. Pulse rate of Comrade Popovich during the insertion and with transition to weightlessness temporarily increased upto 102-104, but subsequently quickly decreased and settled within 60-72.

Respiration rate of both the spacemen is 15-19.

During the flight both the spacemen several times released themselves from the harness, came out from the seats and carried out the required tasks and experiments, provided for by the program.

Pictures of both the spacemen, transmitted by the TV cameras on board, were repeatedly translated by Central Television and Intervision directly from aboard the spaceships.

In accordance with the program spaceman Nikolaev from 21 hrs and spaceman Popovich from 21 hours 30 minutes Moscow time should sleep.

Comrade Popovich has requested to congratulate in his name the team "Shakhter" with winning in football the Cup of the Soviet Union.

"Pravda", 13th August 1962.

GRATITUDE OF CREATORS OF SPACESHIPS:

The Soviet spacemen A.G. Nikolaev and P. R. Popovich transmitted on the 13th of August from spaceships "Vostok-3" and "Vostok-4", conducting group flight in space, the following radiogram:

"To Soviet Scientists, Designers, Engineers, Technicians and Workers.

Dear Comrades! We are sincerely grateful to you for the creation of wonderful spaceships and our excellent preparation for the flight. We wish you further successes in your labor for the good of our Beloved Motherland. Pilots cosmonauts Nikolaev, Popovich".

"Pravda", 14th August 1962.

TASS COMMUNIQUE-THE RESEARCH PROGRAM IS BEING SUCCESSFULLY IMPLEMENTED:

13th August, 6 hours.

The group space flight of the spaceships satellites "Vostok-3" and "Vostok-4" continues. At 6 hours Moscow time on the 13th of August the spaceship "Vostok-3" completed 29 revolutions around the earch, covering about 1 million 200 thousand km, which is over three times the distance from the earch to the Moon. Spaceship "Vostok-4" covered over 530 thousand km and completed 13 revolutions around the earth.

During the sleep of the spacemen from 4 hours 30 min. Moscow time, the operation of instruments was automatic and controlled by telemetry. Simultaneously the condition was being checked of the sleeping spacemen. All the units and instruments of spaceships operate normally. The spacemen feel fine.

After awaking comrades Nikolaev and Popovich did the physical exercises, took breakfast and started the implementation of the program, planned for the 13th of August.

Communication of spacemen with the earth and with each other continues in accordance with the program of the group space flight.

8 hours.

At 8 hours Moscow time on the 13th of August spaceship satellite "Vostok-3" accomplishes its 31st revolution around the earth, having covered about 1 million 250 thousand km. The spaceship satellite "Vostok-4" has orbitted the earth more than 14 times, covering distance of about 590 thousand km.

The spaceman Comrades Nikolaev and Popovich informed, that they have slept well and are feeling quite fit. During the sleep the pulse of both the spacemen was about 60. The equipment of spaceships functions unfailingly.

Morning hours of the spacemen were given over to scientific observations, physiological, vestibular and psychological tests. Spaceman Nikolaev, whose flight is continuing for almost 48 hours, and spaceman Popovich, who is in space flight for 21 hours have fully retained their efficiency and successfully implemented the flight program.

Group flight of spaceships "Vostok-3" and "Vostok-4" continues.

12 hours.

At 12 hours Moscow time on the 13th of August spaceship satellite "Vostok-3", manned by the spaceship Povovich orbitted the earth 17 times. The space flight of Comrade Nikolaev is continuing over 48 hours. Group flight has been continuing for 25 hours.

Telemetric checking data of the physical state of the spacemen indicate their excellent condition and efficiency. The pulse of Comrades Nikolaev and Popovich is steady, 60-65. Temperature in the cabins of "Vostok-3" and "Vostok-4" is 15-18°C. Composition, humidity and pressure of air are normal. The necessary medical and hygienic conditions in the cabins are fully maintained. Comrades Nikolaev and Popovich inform, that they are feeling fine and the program of the flight is being successfully implemented.

The automatic command and measuring complex with Coordination Center assure implementation of all the orbital and telemetric measurements provided in the program and their continuous processing and transmission of necessary information on board the spaceships.

16 hours.

The group flight of the Soviet Spacemen proceds successfully. At 16 hours Moscow time on the 13th of August Comrade Nikolaev on spaceship "Vostok-3" completed over 35 revolutions around the earth. Comrade Popovich on spaceship "Vostok-4" over 19 revolutions.

On the 19th revolution there was a routine session of TV transmission from aboard spaceship "Vostok-4" and on the 36th revolution - from aboard spaceship "Vostok-3". The transmission was translated by Central Television and Intervision.

The spacemen still feel fine and carry out regular scientific observations.

Comrade Nikolaev informed, that he made a lot of interesting entries in the log book of the spaceship "Vostok-3".

Regular radio-communication is being maintained between the spaceships and of spaceships with ground centers.

19 hours.

The spaceships "Vostok-3" and "Vostok-4" continue to orbit our planet.

Spaceship "Vostok-3", manned by Comrade Nikolaev, at 19 hours Moscow time on the 13th of August completed over 37 revolutions around the earth, having flown above a million and a half km, which is four times the distance from the darth to the moon. Spaceship "Vostok-4" by this time has made over 21 revolutions.

Comrade Nikolaev, while flying above Europe, transmitted greeting to the people of Scandinavia and West-European countries and wished them peace and happiness.

In accordance with the program the spacemen continue scientific observations. They had released themselves of the harness, took over control of the spaceship and carried out the necessary measurements, recording the results of experiments in log books.

The spacemen Nikolaev and Popovich maintain a steady two-way communication with each other and exchange technical information.

Both men feel well, their mood is cheerful. They inform, that they had their lunch with appetite.

The equipment on spaceships "Vostok-3" and "Vostok-4" functioning normally.

22 hours.

At 22 hours Moscow time on the 13th of August Soviet spaceships "Vostok-3" and "Vostok-4" continue their group space flight.

At this time "Vostok-3" has completed 40 revolutions around the earth and covered about one million 650 thousand km, and "Vostok-4" made 24 revolutions, covering about one million km. The spacemen have completed the program of research, set for the 13th of August.

The instruments and equipment of the spaceships operate unfailingly. The telemetry system provides reliable control of the functioning of instruments and units aboard the spaceships. Moreover, the telemetric measurements make it possible to carry on objective observations of the state of the spacemen's health.

On conclusion of medical specialists, the health of both the spacemen is excellent. The pulse and respiration are normal. The efficiency is fully retained. Mood is cheerful. Appetite of both the spacemen in conditions of space flight is good.

According to the measuring complex data, processed in Coordination Center, orbital parameters of "Vostok-3" and "Vostok-4" at 22 hours on the 13th of August were as follows: orbital period 88.13 and 88.26 min., apogee distance - 221 and 229 km, perigee distance - 173 and 176 km, orbital inclination $64^{\circ}50'$ and $64^{\circ}57'$.

Continuous two-way communication is being maintained between the spacemen.

Today during the day television transmissions were repeatedly conducted directly from aboard the spaceships. Millions of viewers in the Soviet Union and in Europe watched on the screens of their TV sets the calm, smiling faces of the spacemen. Comrade Popovich during the session on the 23rd revolution greeted the viewers and graphically demonstrated the weightlessness of objects, letting them "float" in front of the TV camera objective.

At the moment the spacemen, having completed their routine working day in space are asleep.

"Pravda", 12th August 1962.

THE SPACE IS TALKING TO THE EARTH:

Good wishes to the nations of the world:

While orbitting around the earth, the Soviet spaceman Nikolaev has transmitted from aboard the spaceship "Vostok-3" the following radiograms:

"Flying above the African continent I warmly greet from aboard the Soviet spaceship "Vostok-3" the freedom loving people of Africa. Spaceman Nikolaev".

"Sincere greetings and best wishes from aboard Soviet spaceship "Vostok-3" to the true friends of my motherland - people of the socialist countries. Spaceman Nikolaev."

"Greetings from aboard the Soviet spaceship "Vostok-3" to the peoples of Latin America. I wish you happiness and peace. Spaceman Nikolaev".

"Flying above your great country I greet from aboard the Soviet spaceship "Vostok-3" the telented American people. I wish peace and happiness to the people of your country. Spaceman Nikolaev".

Flying above Asia the Soviet spaceman comrade Nikolaev radioed:

I transmit sincere greeting from space to brotherly people of Great China, Mongolian Peoples Republic, Korean Democratic Peoples Republic, Democratic Republic of Vietnam, who build socialism in their countries. Wish you new great successes. Spaceman Nikolaev".

"I send my greetings from space to the peoples of India, Indonesia, Afghanistan, Laos, Burma, Ceylon and Cambodia. Let the sun of peace and happiness always shine above your countries. Spaceman Nikolaev".

"We send from aboard spaceships "Vostok-3" and "Vostok-4" our greetings and wishes for peace on earth to all the people of goodwill. Spacemen Nikolaev and Popovich".

In reply to hearty congratulations of spacemen friends Comrades Nikolaev and Popovich radioed:

"Dear friends, we like you to know, that everything is in order. All the systems operate perfectly. There is full comfort on spaceships. Your hopes will be warranted. Untill we meet. We embrace and kiss you. Pavel, Andriyan".

A group of Soviet corresponds have greeted the spacemen from the correspondents and Soviet readers. They have asked them to say a few words about the space flight and their impressions. On the 14th of August the following radiograms were received from the spacemen.

Radiogram from Comrade Nikolaev:

"Dear Comrades and friends, thank you very much for your kind greeting and wishes. Everything is in order here. The systems operate perfectly. I feel fine. The flight is being implemented in accordance with prescribed program. Until we meet soon, dear friends, on the earth dear to us. To everybody, to all space greeting. Spaceman Nikolaev".

Radiogram from Comrade Popovich:

"Dear friends, thank you for your attention. I feel fine. When I land I will tell you a lot of interesting things. Spaceman Popovich".

(TASS)

LET THE SKY BE ALWAYS PEACEFUL:

The spacemen reply to participants of Youth Convention:

The participants of the VI Convention of the World Federation of Democratic Youth greeted with enthusiasm the communique of a new Soviet success in space.

Greeting from the participants of Convention was transmitted to spaceships "Vostok-3" and "Vostok-4".

In answering radiogram the spacemen Nikolaev and Popovich transmitted:

"Warsaw, VI Assembly of the World Federation of Democratic Youth.

Dear friends, we thank the participants of the VI Convention for their warm greeting and best wishes for success in our flight. We send you, Ambassadors of Youth, our sincere greeting. We heartily wish, that the meeting in Warsaw would help the youth of various countries to unite their efforts in the struggle for peace, universal disarmament and a better future.

Let the sky be always peaceful above our beautiful earth,

Spacemen Andriyan Nikolaev and Paval Popovich".

"Pravda", 15th August 1962.

TASS COMMUNIQUE - EXACTLY ACCORDING TO PROGRAM:

14th August 6 hours.

At 6 hours Moscow time on he 14th of August the spaceship "Vostok-3" has completed 46 revolutions around the earth, and spaceship "Vostok-4" - 30 revolutions.

According to flight program from 21 hours on the 13th of August till 4 hours on the 14th of August the spacemen Nikolaev and Popovich were sleeping, During this time the control of the spaceships and of equipment was automatic, Simultaneously by means of telemetry the pulse and respiration of the sleeping spacemen were being recorded, and air parameters in space cabins measured.

On awaking Comrades Nikolaev and Popovich did their physical exercises and took the breakfast.

Contacting by radio earth they communicated, that they slept well, feel fine, pressure and humidity of air in the cabins are, as before, normal. Now the spacemen have started to carry out their numerous and composite duties in accordance with the program of space research, planned for the 14th of August.

The group flight of spaceships "Vostok-3" and "Vostok-4" is continuing in accordance with the planned program.

8 hours.

On the 14th of August at 8 hours Moscow time the spacemen were above the southern hemisphere. The spaceship "Vostok-3" was on its 47th revolution around the earth, spaceship "Vostok-4" 31st revolution.

The research in accordance with the planned program is continuing at both the spaceships. The results are recorded by spacemen in log books and on tape-recorders, as well as being regularly transmitted to the earth. Comrade Nikolaev has been observing the moon and had it filmed. He informed, that the temperature in the cabin of "Vostok-3" is 20°C, pressure 1.2 atm., humidity 75%. In communication of Comrade Popovich, temperature in the cabin is 15°C, pressure 1.1 atm., humidity 75%.

The feeling and mood of the spacemen are excellent. Medical observation data indicate, that they stand the conditions of flight very well. The pulse rate of the spacemen is 60-65, respiration rate 10-12. Both the spacemen have medically checked themselves and informed, that the results of checking are good.

A greeting was transmitted on board the spaceships from a group of correspondents, who saw them off into the space journey. They wished in the name of Soviet readers bon voyage to the spacemen. Comrades Nikolaev and Popovich thank them for their congratulations and transmitted to the earth a greeting from space,

12 hours.

At 12 hours Moscow time on the 14th of August spaceship "Vostok-3" has completed during the three days 49 revolutions around the earth, covering distance of over two million km. Spaceship "Vostok-4" is now over two days in flight, it has orbitted the earth 33 times and covered a distance of over one million 400 thousand km.

The spacemen feel fine, Comrades Nikolaev and Popovich successfully carry on the planned flight program and maintain a stable contact with the earth and with each other. The equipment of the spaceships functions normally. Normal conditions are maintained in space cabins. The spacemen can adjust as they wish the air temperature within certain limits to build more suitable conditions in the space cabin. The group space flight of "Vostok-3" and "Vostok-4" continues in accordance with the program.

16 hours.

The Soviet spaceships "Vostok-3" and "Vostok-4" continue their prolonged orbitting of the Globe. At 16 hours Moscow time on the 14th of August "Vostok-3" has completed 52 revolutions around the earth, and "Vostok - 4" - 36 revolutions.

At 13 hours 04 min. on the 14th of August spacemen Nikolaev and Popovich in a joint radiogram have reported to the Soviet people, Central Committee CPSU, Government of USSR on the successful completion of the third day of the space flight, thanked them for the fatherly care and assured, that the planned flight program will be fully implemented.

Having become adapted to conditions of prolonged space flight, the spacemen continue the scientific observations. In accordance with the program Comrades Nikolaev and Popovich release them-selves periodically from harness, leave their seats and study the effect of weightlessness on the movement coordination and efficiency in space flight.

The condition and mood of the spacemen is excellent. The equipment of spaceships operates normally.

21 hours.

The spacemen Nikolaev and Popovich have completed one more day of tension and work in space. At 21 hours Moscow time on the 14th of August the spaceship "Vostok-3" completed over 55 revolutions around the earth, and spaceship "Vostok-4" - over 39 revolutions.

The spaceship "Vostok-3" has been in space flight for over 81 hours. Distance covered during this time is about two million 300 thousand km, which is 6 times the distance from the earth to the moon. The spaceship "Vostok-4" covered during 58 hours over one million 600 thousand km.

The group flight of spaceships proceeds normally, in full conformity with the preset program. All the units and systems of spaceships function unfailingly. Orbital parameters of "Vostok-3" and "Vostok-4" at 21 hours on the 14th of August are respectively as follows: orbital period - 88.028 and 88.179 min., apogee distance - 214 and 224 km, perigee distance 170 and 173 km, orbittal inclination - 64°59' and 64°57'.

Continuous two-way radio-communication is being maintained between the two spaceships. On the 14th of August during the passage of spaceships above the USSR territory from the Central television and Intervision repeatedly transmissions were made directly from the spaceships.

The observation is being continued of the spacemen's condition and efficiency. The continuously incoming telemetric information, TV observations and reports of the spacemen indicate, that conditions in space cabins are normal, which the spacemen themselves describe as comfortable. The temperature humidity and pressure of air are optimum. The recorded physiological functions show no departure from the normal. The spacemen feel fit, their mood is cheerful.

During the group flight of spaceships "Vostok-3" and "Vostok-4" extremely valuable data were obtained for investigation of the effect of prolonged space flight on physiological and psychological state of the human organism.

Experience, obtained in space flights of Gagarin and Titov made it possible to give an alround preparation of Nikolaev and Popovich for a considerably longer flight.

Great role in accomplishing prolonged space flights was played also by the high moral qualities and will power of the Soviet spacemen.

Pilot cosmonauts Nikolaev and Popovich have successfully accomplished the research program, set for the 14th of August. At present in accordance with the program the spacemen are asleep.

"Pravda", 15th August 1962.

TASS COMMUNIQUE - THE UNPRECEDENTED GROUP FLIGHT IN SPACE IS SUCCESSFULLY COMPLETED:

In accordance with the flight program on the 15th of August 1962 landing was accomplished in western area of spaceships "Vostok-3" with Comrade Nikolaev A.G.and "Vostok-4" with Comrade Popovich P.R. The landing was quite normal:

Landing time of spacemen:

- Comrade Nikolaev A.G. - 9 hours 55 min.,
- Comrade Popovich P.R. - 10 hours 0.1 min.

After the space flight and landing both the spacemen feel very well. Flight program of spaceships "Vostok-3" and "Vostok-4" is fully implemented.

"PRAVDA", 15th August 1962 (Special Edition).

TO COMMUNIST PARTY AND PEOPLES OF THE SOVIET UNION :

TO PEOPLES AND GOVERNMENTS OF ALL THE COUNTRIES :

TO ALL PROGRESSIVE MANKIND :

From Central Committee CPSU, Presidium of the Supreme Council of USSR and the Government of the Soviet Union.

A new glorious page has been written in the chronicle of space conquest. For the first time in the world Soviet spacemen have accomplished on spaceship satellites a heroic, unprecedented in its complexity and duration group space flight.

On the 11th and 12th of August 1962 powerful Soviet rockets have launched into the Earth orbit spaceships "Vostok-3" and "Vostok-4", manned by the citizens of the Union of Soviet Socialist Republics, communists comrades Nikolaev Andriyan Grigor'evich and Popovich Pavel Romanovich.

Displaying great courage and heroism comrades Nikolaev and Popovich have accomplished a many-days group orbiting of the Earth, have brilliantly implemented the planned program and successfully landed in prescribed area on the territory of our Motherland - Union of Soviet Socialist Republics.

The spaceship "Vostok-3", manned by comrade Nikolaev, during 95 hrs, i.e. almost four days, orbited the Globe more than 64 times and covered distance of over 2 million 600 thousand km.

The spaceship "Vostok-4", manned by comrade Popovich, during 71 hrs, i.e. almost three days, orbited our planet more than 48 times and covered a distance of about 2 million km.

The joint flight of the two spaceships was at close distance to each other. There was a direct steady two-way radio-communication between the spacemen. The takeoff and landing of the spaceships were implemented in exact conformity to the planned program. The equipment of the spaceships operated unfailingly throughout the flight. The health state of both the spacemen during the flight was excellent, their mood cheerful, efficiency fully retained. During the flight they implemented a considerable amount of research. They feel quite fit after their return from the composite space flight.

This type of group flight is made possible mainly by the perfection of spaceships, precision of scientific calculations, exceptionally well co-ordinated work of all Soviet people, engaged in the implementation of this responsible assignment.

Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of USSR and the Government of the Soviet Union mark with great joy and satisfaction, that the Soviet spacemen, scientists, designers, engineers, technicians and workers, participating in the construction of spaceships and serving their flight in space, have honorably implemented their duty to the Motherland, to progressive mankind.

The many-days group orbiting of the Earth marks a new step in space research. For the first time during the flight radio-communication was established not only of the spaceship with the Earth, but also between the spaceships, flying at different distances. The science became enriched by most valuable data on the state of human organism in conditions of space flight. The two spacemen in simultaneous group flight, while maintaining reciprocal communication and controlling the ships, coordinated their actions with each other, exchanged information about the conditions, equipment performance, compared results of observations. Now it is quite obvious, that distances, counted in millions of kilometers are possible to Soviet spacemen. The time is not far off, when they will fly powerful spaceships to the planets of Solar System.

The great feat of comrades Nikolaev and Popovich rises even higher the fame of our Fatherland, clearly demonstrates the achievements of the highly-developed Soviet economics, the advanced Soviet science and technique, the undeniable advantages of socialist order.

The Soviet space heroes - are the men, who came out from the common people, brought up in the ranks of our glorious Communist Party. They were raised on the high ideals of socialism and communism, faithful to the end to their people, the Motherland. They embody the undestructible friendship of the socialist nations of USSR. Following the Russian comrades Gagarin and Titov, the space was stormed by the son of Chuvash people comrade Nikolaev and the son of Ukrainian people comrade Popovich. In a single brotherly family the peoples of the Soviet Union build communism, in a single formation they assault the Universe in the interest of peace and progress, happiness of the whole mankind.

The names of communists Yurii Gagarin, German Titov, Andriyan Nikolaev and Pavel Popovich became the personification of the heroism of the reatice genius and industry of our people. Soviet spacemen are the true and worthy sons of our Motherland, great Lenin's Communist Party. Those are men of unflinching courage, great knowledge, high culture and moral purity.

Now the whole world can see, that the communists are steadily in advance of mankind on Earth and in space, that socialism is the reliable takeoff platform, from which the Soviet Union successfully sends into space its powerful and perfect spaceships.

The new outstanding successes in space conquest convincingly show, that communism gains one victory after another in peaceful competition with capitalism. Inspired by the resolutinions of the XXII Convention, by the new Program of the Party, the Soviet people steadily build communist society, paving the way for all the mankind to bright future.

The prevision of the great Lenin of the transforming role of science, technique and culture in the development of society is coming true. "Previously - said Vladimir Il'ich, - the whole human mind, its all genius created only to give to some all the blessings of the technique and culture, and to deprive others of the most necessary - education and development. But now all the miracles of technique, all the cictories of culture will be the property of the masses, and henceforward the human mind and genius will never be converted into means of violence, into means of exploitation. We know this, and is'nt it worth working for, to give all ones efforts for this greatest historical task? And the workers will accomplish this titanic historical job, since it is in them that lie the slumbering great forces of the revolution, rebirth and renewal".

Our party, our people follow the way shown by Lenin. Now all can see, what miracles are accomplished by the gigantic creative powers of the Soviet people, awakened by the revolution.

In our time the science and technique open out limitless possibilities for mastering the forces of nature and their use for the good of man. The great discoveries of science can serve to improve the conditions of life only, when they are used for peaceful purpose, in the name of people's happiness.

The Soviet Government continuously and persistently fights for stable peace in the whole world. And the new flights of the Soviet spaceships were accomplished with peaceful aims.

The mankind craves for stable peace on Earth, and no Government should disregard it. The extent of the people's hatred for the enemies of peace was clearly shown at the World Congress for Universal Disarmament and Peace, held recently in Moscow. In the name of all the peoples the Congress wrathfully condemned the millitarist circles of the Western Powers and called to active struggle for a general and total disarmament under a strict International control, for the banning of nuclear tests for ever.

The Soviet Government again solemnly declares, that it fully supports the demands of the peoples for assuring stable peace in the world and does everything possible to implement these just demands.

The Soviet Government once again appeals to all the Governments and peoples with a call to struggle even more persistently for delivery of mankind from the threat of nuclear war, for indestructible peace on Earth. The Soviet people are confident, that by their persistent struggle the nations will defend the cause of peace.

The heroic feats of pilots cosmonauts comrades Nikolaev and Popovich fill the hearts of Soviet people, all honest people in the world with joy and pride, call our people to new successes in communist building.

Forward, toward the triumph of peace and progress :

Central Committee of CPSU, Presidium of the Supreme Council of USSR

Council of Ministers USSR

"Pravda", 15 August 1962 (Special edition).

FORWARD, TO THE VICTORY OF COMMUNISM :

To scientists and designers, engineers, technicians and workers, all groups and organisations, participating in the accomplishment of the prolonged group space flight of manned spaceship - satellites "Vostok-3" and "Vostok-4".

To Soviet spacemen comrades Nikolaev and Popovich.

Dear Comrades :

The first in the world prolonged group space flight of two Soviet spaceships "Vostok-3" and "Vostok-4", manned by the citizens of the Soviet Union comrades Nikolaev and Popovich has been successfully completed. A new brilliant victory has been won in the mastering of the outer space!

It is gratifying to realize, that the Soviet people were the first to pave the way in the depths of the Universe. The courageous spacemen Andriyan Nikolaev and Pavel Popovich with their record flight and implementation of extensive research program have made a new and worthy contribution into the treasury of advanced Soviet science, augmented the fame of our Motherland. The Soviet people are enraptured with the heroic feat of its sons.

This feat, just as the feat of the first Soviet spacemen will be known for ever, will always be an example of unbending will, courage and valour.

The Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of USSR and the Council of Ministers USSR sincerely and warmly greet and congratulate you, dear comrades Nikolaev and Popovich with successful completion of the long group space flight and safe return to our dear Soviet land. We wish you good health and new successes in your noble work to the glory of Motherland.

The spaceships "Vostok-3" and "Vostok-4" are a new great achievement of the Soviet science and designing. The group space flight on these spaceships is a new triumph of the Soviet science and technique, creative genius of our scientists, designers, engineers, technicians and workers. This flight will have an enormous significance for new flights into space and to other planets of the Solar System. The construction of the spaceships and their equipment have withstood all the tests in the composite conditions of space flight. The spacemen have carried out an extensive program of research, the results of which have enriched the world science.

The construction of the powerful spaceships "Vostok-3" and "Vostok-4", the many days group flight on these spaceships of pilots-cosmonauts A.G. Nikolaev and P.R. Popovich, is a new outstanding contribution to the historic task, set by the XXII Convention of the CPSU to our Soviet science - to take the leading position in the world in all the main spheres of science and technique.

The successes of the Soviet Union in conquering the space once more convincingly show, the inexhaustible creative power possessed by our socialist society. Today the whole world can see of what great feats the Soviet people are capable - people, who are the active and conscientious builders of communism.

Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of USSR and the Council of Ministers USSR heartily and warmly congratulate in the name of the Communist Party, Soviet Government, all the peoples of our Motherland scientists, designers, engineers, technicians, workers, groups and organisations, all those, who participated in construction of the new spaceships "Vostok-3" and Vostok-4", in preparation and successful accomplishment of the group space flight.

Glory to the Soviet scientists, designers, engineers, technicians and workers - creators of remarkable spaceships satellites!

Glory to the valorous Soviet spacemen!

Glory to heroic Soviet people - builders of communism!

Glory to the Communist Party of the Soviet Union - inspirer and organiser of all the victories of the Soviet people!

Forward, to the victory of communism!

Central Committee of CPSU	Presidium of the Supreme Council of USSR	Council of Ministers of USSR

"Pravda", [illegible]

TASS COMMUNIQUE - PRIOR TO TERMINATION OF HISTORIC FLIGHT.

15 August, 6 o'clock in the morning.

At 6 o'clock Moscow time on the 15th of August spaceship "Vostok-3" has completed over 61 revolutions around the Earth, and the spaceship "Vostok-4" - over 45 revolutions.

After their sleep till 3 hrs 30 min the spacemen comrades Nikolaev and Popovich began further implementation of the flight program. The condition and mood of the spacemen are excellent. All the systems and units aboard the spaceships operate normally. Normal life support conditions are maintained in the space cabins.

The group space flight of the spaceships satellites "Vostok-3" and "Vostok-4", manned by comrades Nikolaev and Popovich continues in accordance with the planned program.

8 o'clock in the morning.

At 8 hrs Moscow time on the 15th of August the Soviet spaceships are continuing their unprecedented space flight. By this time spaceship "Vostok-3" made 63 revolutions, covering over 2.5 million km, and the spaceship "Vostok-4" has orbited the Earth 47 times, covering a distance of about 2 million km. Both the spacemen as before feel fit. Their mood is cheerful. Comrades Nikolaev and Popovich continue implementation of the flight program.

"Pravda", 1[illegible] August 1962. Special edition.

BEST WISHES TO THE NATIONS OF THE WORLD.

Flying above Australia Soviet spaceman comrade Nikolaev radioed! "Best wishes from aboard the Soviet spaceship "Vostok-3" to Australian people. Wish you peace and well being. Spaceman Nikolaev".

While orbiting the Earth spaceman comrade Popovich transmitted radiogram: "I send greetings from aboard the Soviet spaceship "Vostok-4" to brotherly people of the great China, Korean Democratic People's Republic, Democratic Republic of Vietnam, Mongolia and wish them new successes in the building of socialism. Spaceman Popovich".

Radio message from spaceman Nikolaev: "Best wishes from the Soviet spaceship "Vostok-3" to the people of England, France, Italy and West Germany. Let there be peace in Europe. Spaceman Nikolaev".

"Greetings and best wishes to Scandinavian people from the Soviet spaceship "Vostok-3". Spaceman Nikolaev".

"Best wishes from the Soviet spaceship "Vostok-3" to the people of Near and Middle East. Let the sky be peaceful above your countries. Spaceman Nikolaev".

While orbiting around the Earth, Soviet spaceman Popovich transmitted the following radiogram: "Being above Europe, I send from Soviet spaceship "Vostok-4" greetings and wishes for new successes to brotherly people of socialist countries. Spaceman Popovich".

"Warm greetings and best wishes from Soviet spaceship "Vostok-4" to the People of India, Indonesia, Burma, Afghanistan, Ceylon, Laos and Cambodia. Let there be peace and friendship in your life. Spaceman Popovich".

"Flying above Europe I send my greetings from Soviet spaceship "Vostok-4" to the people of France, Italy, England and West Germany. I wish peace and friendship to all the nations. Spaceman Popovich".

"Pravda", 15 August 1962. (Special edition). (TASS)

TASS COMMUNIQUE - THE PROGRAM FULLY IMPLEMENTED.

The group-flight program of spaceships "Vostok-3" and "Vostok-4", manned by the USSR citizens Maj. Nikolaev Andriyan Grigor'evich and Lt. Col. Popovich Pavel Romanovich, has been fully completed.

On the 15th of August 1962 the spaceships landed practically simultaneously in a prescribed area of the Soviet Union, south of the Karaganda city of Kazakh SSR, in the immediate vicinity of calculated landing places.

Both the spacemen feel physically fit after the landing.

The spacemen Nikolaev and Popovich were met on their landing by doctors, friends, correspondents and sport Commissars.

The flight of spaceship "Vostok-3", manned by comrade Nikolaev continued for 95 hrs, i.e. almost four days. During this time "Vostok-3" orbited the Earth more than 64 times, covering a distance of over 2 million 600 thousand km.

The spaceflight of "Vostok-4", manned by comrade Popovich lasted 71 hrs, during which he orbited the Globe 48 times. Distance covered is about 2 million km.

The group flight of both the spaceships composed 71 hrs, i.e. almost three days.

The scientific and technical problems of unprecedented in duration space flight of "Vostok-3" and "Vostok-4" and of the first group flight have been fully and successfully resovled.

A two-way radio-communication was established for the first time between two spaceships during the group flight. During the flight the spacemen conversed, exchanged results of their observations and coordinated their actions. Valuable data were obtained for setting up communication during the prolonged space flights.

All the systems and units of spaceships and the scientific instruments aboard functioned normally and unfailingly from the moment of takeoff till the landing.

The Soviet spacemen have skilfully conducted this composite flight, controlling the spaceships and carrying out considerable amount of research in accordance with the assignment.

Objective data of the medical checking of the spacemen's state, which was kept up during the whole flight, have shown, that the spacemen comrades Nikolaev and Popovich have stood very well the orbital insertion, many days flight and return to Earth.

In this remarkable flight comrades Nikolaev and Popovich have shown an exceptional courage and valor, thus demonstrating to the world the high moral qualities of a Soviet Man.

This flight is a new important stage in the peaceful conquest of the space.

As a result of the group flight of spaceships "Vostok-3" and "Vostok-4" material was obtained of enormous scientific and technical value, which will be of exceptional significance for further mastering of the outer space and implementation of the ages-old aspirations of mankind - flights to other planets and worlds.

"[illegible]", [illegible].

DECREE OF THE PRESIDIUM OF THE SUPREME COUNCIL USSR ABOUT CONFERRING THE TITLE OF THE HERO OF THE SOVIET UNION ON PILOTS COSMONAUTS MAJ. NIKOLAEV A.G. AND LT. COL. POPOVICH P.R.

For accomplishing the first in the world prolonged group space flight on spaceships satellites "Vostok-3" and "Vostok-4" to confer title Hero of the Soviet Union with order of Lenin and "Gold Star" medal to:

Pilot-cosmonaut Major Nikolaev Andriyan Grigor'evich,

Pilot-cosmonaut Lt-Col. Popovich Pavel Romanovich.

L. Brezhnev

Chairman Presidium of the Supreme Council USSR

M. Geogadze

Secretary Presidium of the Supreme Council USSR

Moscow, Kremlin. 18 August 1962.

DECREE OF THE PRESIDIUM OF THE SUPREME COUNCIL USSR FOR CONFERRING THE TITLE "PILOT COSMONAUT USSR" ON MAJOR NIKOLAEV A.G. AND LIEUT. COL. POPOVICH P.R.

For accomplishing a prolonged group space flight on spaceships satellites "Vostok-3" and "Vostok-4" to confer the title of "Pilot cosmonaut of USSR" to citizens of the Soviet Union:

Major Nikolaev Andriyan Grigor'evich,

Lieut. Col. Popovich Pavel Romanovich.

L.Brezhnev

Chairman Presidium of the Supreme Council USSR

M.Georgadze

Secretary Presidium of the Supreme Council USSR

Moscow, Kremlin, 18 August 1962.

"Pravda", 19 August 1962.

PRESS CONFERENCE ON THE FLIGHT OF ANDRIYAN NIKOLAEV AND PAVEL POPOVICH.

Yesterday in the Assembly Hall of the Moscow M.V. Lomonosov State University a press conference was held of the Soviet and foreign correspondents, dealing with the first in history prolonged group flight of the Soviet spaceships "Vostok-3" and "Vostok-4".

At this meeting, arranged by the Academy of Sciences USSR and the Ministry of Foreign Affairs USSR, there were over 2000 people. These included hundreds of foreign and Soviet correspondents and commentators of newspapers, journals, radio and television of every continent. There were Soviet scientists and culture workers, representatives of social organizations, and of the Capital's enterprises. Invitations were sent to the heads of diplomatic missions, accredited in USSR.

The participants of the press conference warmly greeted Heroes of the Soviet Union pilots cosmonauts Gagarin Uy. A., Titov G.S., Nikolaev A.G. and Popovich P.R.

The gathering listened with great interest to the speeches of scientists, who spoke of the first results of the unprecedented stellar flight, which has fixed for ever the priority of the Soviet science and technique in the mastering of the unknown depths of the Universe for the good of mankind. Heroes of the Soviet Union pilots cosmonauts Andriyan Grigor'evich Nikolaev and Pavel Romanovich Popovich addressed the press conference and were listened to with great attention.

<u>The way into the space is open!</u>

<u>Opening address by M.V. Keldysh, President of the Academy of Sciences USSR.</u>

Dear comrades! Ladies and Gentlemen!

On the 15th of August 1962 the first in the world group flight of Soviet spaceships "Vostok-3" and "Vostok-4", manned by pilots cosmonauts comrades Nikolaev and Popovich [illegible] completed.

For 71 hrs the spacemen Nikolaev and Popovich were in a joint flight, covering during this time distance four times the distance from Earth to the Moon and back.

During his unprecedented flight, beginning on the 11th of August 1962 at 11 hrs 30 min Moscow time, comrade Nikolaev has covered over 2 million 600 thousand km and orbited the Globe more than 64 times. The remarkable flight of comrade Popovich began on the 12th of August 1962 at 11 hrs 02 min Moscow time; he covered over 2 million km and orbited the Earth more than 48 times.

After fully completing the flight program the spacemen with high precision almost simultaneously safely landed in the area south of Karaganda each at an earlier prescribed area.

The flights of spaceships "Vostok-3" and "Vostok-4", which astounded the whole world, were implemented in accordance with the program of study and mastering of space, conducted by the Soviet Union for peaceful purpose. The outstanding achievement of the Soviet science and technique has been accomplished for the good of the whole world.

The way into space, opened out by Yurii Gagarin and Herman Titov, becomes a highway, which is leading the mankind to new victories of the mind and labor. The flights of Andriyan Nikolaev and Pavel Popovich on spaceships "Vostok-3" and "Vostok-4" is a new important step of this way, bringing us nearer to realisation of interplanetary flights.

The group flight of the spaceships is of high significance for working out interplanetary stations, for constructing even more perfect spaceships, for the mastering of interplanetary routes.

To carry out a group space flight of several days required construction of improved spaceships satellites. The perfect control systems of the spaceships enabled to implement exactly the flight program. The performance of all the systems aboard the spaceships was specially efficient in the most difficult brances of the flight - the orbital insertion of the spaceships satellites was unusually precise and their descent was faultless.

"Vostok-3" and "Vostok-4" carried an improved set of radio equipment for communication, improved TV equipment and special additional automatic equipment, providing for a two-way direct conversation between the spaceships.

A wide network of ground stations make it possible to conduct direct conversation with the spaceships practically from any point in the Soviet Union. Frequently the two-way conversations with the spaceman on ultrashort wave were conducted at a distance of several thousand km, and on short-wave band a number of cases were recorded, when the distance of communication was over 10 thousand km.

Very efficiently and fast worked the ground receiving and transmitting stations, which used powerful directional systems, changed-over according to target indication, incoming continuously from the Coordination centre.

The prolonged flight program enabled the sapcemen to leave their seat and freely float around the cabin and to carry out different operations. During the free floating the spacemen conducted radio-communication by means of special loud-speakers and microphones, which provided for almost invariable audibility of transmissions from the Earth and loudness of the spacemen's transmissions to Earth from any point of the cabin.

The long duration of the flight, two-way conversations of spacemen and intensity of radio-communication of spacemen with the Earth enabled to accumulate an extremely valuable material on the passage of radio-waves and establishment of radio-contact simultaneously with several spaceships.

The construction of improved spaceships satellites "Vostok-3" and "Vostok-4" and the specially adopted measures made possible prolonged flight in conditions of the outer space.

Due to the adopted measures the weightlessness and other factors did not affect the efficiency of the spacemen, did not prevent comrades Nikolaev and Popovich to carry out the whole planned flight program.

Methods for preparing the spacemen, worked out by the Soviet scientists, based on the experience of a 24-hour flight of H.S. Titov, enabled Lt. Col. Popovich and Maj. Nikolaev to retain their wellbeing throughout the several days flight.

The unprecedented duration of Nikolaev and Popovich flight, the uninterrupted operation of the whole scientific equipment, active participation of the spacemen themselves in conducting the research have provided the Soviet science with new invaluable information of the effect of space flight on human organism. The results of these flights gives us an assurance, that conditions can be created for preserving the wellbeing and efficiency of spacemen in long-lasting space flights.

All data, obtained during the group space flight, are being carefully processed; the results of research will be published and will be a new great contribution of the Soviet science to the cause of peaceful conquest of the outer space.

The group flights of the spaceships satellites "Vostok-3" and Vostok-4", which intiated coordinated group actions of a man in space, are an outstanding step toward the mastering of the outer space. They have convincingly shown the possibility of a free manned space flight, have shown ways for accomplishing even more composite and prolonged flights, both in the Earth orbit and to other planets.

The prolonged group space flight is an outstanding feat of scientists, designers, engineers, workers, and outstanding feat of the worthy sons of the people pilots cosmonauts Andriyan Grigor'evich Nikolaev and Pavel Romanovich Popovich. Their courage, skill, self-discipline assured carrying out of the first in the world group flight, which has written a new glorious page in the chronicle of the feats of Soviet people, Soviet science and technique, accomplished in the name of the Motherland, in the name of the peace and progress of the whole mankind.

The flight is a new proof of the amount contributed to the treasury of universal culture by the free people of socialist countries, people, who create the greatest thing in the history of mankind - build communist society.

Dear Andriyan Grigor'evich and Pavel Romanovich!

The whole Soviet people, the shole mankind with great attention and admiration followed your unprecedented flight and greeted with enthusiasm your return to the Soviet land. The Party. Government, the whole Soviet people highly value your immortal feat. The titles of the Heroes of the Soviet Union and Pilots-Cosmonauts of the Soviet Union were conferred on you.

Allow me to welcome you, dear Andriyan Grigor'evich and Pavel Romanovich in the name of the Academy of Sciences, of all the scientists of the Soviet Union and of all those present in the Hall.

The Academy of Sciences of the Soviet Union, taking into account the outstanding significance of your flight for the science, for cosmonautics, has awarded to you gold medals, bearing the name of our outstanding countryman, great scientist, who was the first to forecast the possibility of space flights and outlined the ways for their accomplishment, K.E. Tsiolkovsky - the founder of the theory of rocket technique and space flights. It gives me great joy in handing you these medals.

Man in space cabin.

Address by Prof. V.I. Yazdovskii.

Dear comrades! Ladies and Gentlemen!

Among the many problems, on the resolution of which depends success of future space travel, one of the most essential is the proglonged effect on a man of the factors of space flight.

The experimental study of the effect of these factors, specially of weightlessness, is only possible in conditions of actual flight on space vehicles. In this connection an exceptional interest represents the use of inhabited spaceships satellites as a unique laboratory base for preparing distant space trips.

The remarkable orbital flights of Soviet spacemen U. A. Gagarin and H.S. Titov have proved, that a man can endure 24-hour being in space. This conclusion was confirmed also by data physiological investigations, conducted during the flights of American spacemen Glenn and Carpenter.

The most prolonged of these flights was the 24-hour voyage of Maj. Titov. He prepared the grounds for a more decisive penetration of a man into the space.

After the flight of Yu. A. Gagarin and H.S. Titov the Soviet scientists and designers carried out a great amount of investigations, directed at rising physiological stability of a man against the effect of space-flight factors and some improvement of conditions for a longer staying of a man in space cabin.

H.S. Titov, as we know, has shown some organic disorders during the flight.

Careful analysis of the indicated manifestations enabled to assume, that reactions of organism to conditions of space flight depend mainly on the coordination of the physiological system of space analyzers (vestibular, visual, motor, etc.). It was ascertained, that under the conditions of weightlessness the disorders are possible in the interaction of the enumerated analyzers and changes in the sensitivity threshold of vestibular apparatus. As a result prolonged effect of even insignificant vestibular irritants, specially the Coriolis acceleration, causes symptoms, resembling sea-sickness.

All this was the basis for the careful selection of the spacemen with the use of specially developed methods for investigation of vestibular reactions, permitting to determine functioning of vestibular apparatus in conditions of interaction with motor and visual analyzers, and also for developing methods for training physiological system of vestibular and motor analyzers.

At the end of the spacemen's preparation it was defined, that the stability of vestibular apparatus against the linear, angular, Coriolis accelerations and their combined effect was higher than the initial data several times.

With the object of constant and more complete checking of the spacemen's state and conditions in the space cabins the volume of scientific information from aboard the spaceships has been considerably increased.

The most important scientific problems of medico-biological investigations in flights of spaceships "Vostok-3" and "Vostok-4" were the following :

- Study of the state of the main physiological functions of a man in prolonged space flight.

- Study of the daily periodicity of physiological processes in conditions of prolonged Earth orbiting.

- Study of the efficiency of spacemen at various branches of the spaceship's flight.

- Study of effectivity of selection and training methods of spacemen for space flights.

- Study of the performance of life support and safety systems in flight.

The basic methods for studying the state and efficiency of spacemen were:

- Biotelemetric information, characterising the state of the main physiological systems of the organism.

- Television observation of the spacemen, which enabled to get an idea of behavior, motor activity, coordination of movements and attitude.

- Radio-exchange along the communication channels of the spaceship with Earth, on the basis of which it was possible to draw conclusion about the efficiency, any peculiarities in speech, accuracy in carrying out individual operations.

- Evaluation of the volume and quality in carrying out flight assignment in all its numerous and different in nature details.

As a result of the several days flight exceptionally extensive and most valuable scientific data were accumulated, a part of which even during the flight was subjected to express processing, and the main material is being now carefully analyzed.

On the basis of preliminary data it is possible to point out, + pulsion branch of the flight - orbital insertion - A. Nikolaev and P. Popovich stood quite well. Physiological reactions differed little in heir nature from these recorded in the flights of Yu. Gagarin and H. Titov. Pulse rate of A. Nikolaev during the propulsion period was upto 120, and of P. Popovich - 130. Respiration about 10 and 20 respectively.

After the orbital insertion in conditions of weightlessness there was a comparatively rapid return of these indices to the values of pretakeoff period.

At the end of the first and beginning of the second revolution the pulse and respiration rate already corresponded to values, recorded a few minutes before takeoff. By the sixth revolution the pulse and respiration rate was almost the same as recorded in spacemen a few hours before the start.

During the following four days in A. Nikolaev and the three days in P. Popovich the pulse rate was maintained at 60-70, and respiration at 10-15 per minute.

Quite explainable quickening of these indices was noticed prior to descent of the vehicles to Earth.

It should be emphasized, that no pathological changes what so ever were noticed on the cardiograms of both the spacemen. In general examination no noticeable disorders were defined in the pattern of encephalograms, electro-oculograms and recordings of cutaneous galvanic reaction.

Very serious attention was paid to the study of functional state of vestibular apparatus in joint activity with others, closely connected analyzers.

The preliminary data indicate high stability of the spacemen. This is the result of special measures.

Taking into account the probable individual effect of weightlessness and possible reaction to the absence of gravity of other organs and systems of a man, the problem of weightlessness will figure even more in further investigations.

At the same time very optimistic results were obtained in regard movement coordination and the capacity of a man to move freely and to implement the most diverse movements in the state of weightlessness, when the spacemen were getting out of the harness and their seats. Moreover they retained their space orientation, which was disturbed only with the closing of eyes.

On the whole the efficiency of A. Nikolaev and P. Popovich was retained at quite a high level throughout the flight. Implementation of assigned operations and research tests did not cause any difficulties. Their sleep was not distinct by any peculiarities and was quite restful.

The appetite was normal. Chewing and swallowing presented no difficulties. The approximation of the ration to the usual was undoubtedly of a positive effect. It was approved and highly appreciated by the spacemen. I must mention, that individual tests of A. Nikolaev and P. Popovich were taken into account.

It is very important to mention, that the hygienic conditions of both the space cabins were maintained throughout the flight within the present limits and were optimal.

The program of biological research, carried out by the spacemen, deserves special mention. It is premature to speak of results, the material is being processed, however the fact itself of the experimental work being done by a man in space flight is a new and important achievement.

The group flight of A. Nikolaev and P. Popovich has terminated exceptionally successfully.

No pathological changes whatsoever was detected in the health of the spacemen.

As a result of carried out investigations a lot of new scientific data were obtained, required for preparing subsequent more composite space flights.

In conclusion permit me in the name of scientists, doctors and biologists to express our gratitude to Andriyan Grigor'evich Nikolaev and Pavel Romanovich Popovich for their brilliant implementation of the flight, patience and understanding, shown in the numerous examinations and medical tests, and also their exceptional accuracy and punctuality in the carrying out of scientific program.

Thank you for your attention.

Reliability of technical equipment.

Address of Academician A.A. Blagonravov.

For over a week now the attention of the world press and people of the whole Globe is centered on the group flight of Soviet pilots cosmonauts comrades Nikolaev and Popovich. This even is, undoubtedly, a technological breakthrough and indicates a new progress in space research, being conducted in the Soviet Union. But what is there in this event, that rivets the attention of the people, what astonishes them? It seems to me, that what astonishes primarily is the bold assurance, with which the spacemen conduct flights in the Soviet Union, astonishes the fact of the new tasks set in this case, pursuing the object of progressively deeper and sure penetration of a man into space. What builds up this assurance? It is known, at enormous significance in technique has reliability of the technical equipment, machines, erections.

Specially acute it becomes for a multicomponent technical equipment, including an abundance of diverse units and details. In order to accomplish the orbital flight of a man around the Globe it was necessary to construct powerful multistage rockets, capable of imparting to the heavy spaceship satellite the orbital velocity, which required development of appropriate engines, required calculation and accomplishment of the exact separation of the rocket stages, to execute at the right moment directional separation of the spaceship from the last rocket stage. It was necessary to construct the spaceship itself, providing comfortable stay for the spaceman, i.e. having the required atmosphere inside, of certain temperature, pressure and humidity, to provide control of these conditions both automatic and in the case of need - by the spaceman himself. It was necessary to construct control system of the spaceship, to obtain its required orientation in space, to transfer it at a desired moment from the orbit to descent trajectory by changing its velocity and, finally, to provide safe landing in prescribed area. Even one incomplete list of the problems, which had to be resolved, gives an idea of the complexity of the technical means, as a result of which the whole system of the carrier-rocket and the spaceship had to be multicomponent, consisting of hundreds of thousands of separate details. And if we add the communication means with Earth, means of communication between two spaceships, means of observation, means of flight control, ground start equipment, then indeed this whole multicomponent system is a grandiose construction, grandiose result of human mind. And thus, to get the assurance of a complete success of the experiment, and the Soviet scientists and engineers did have this assurance, it was necessary to provide complete reliability, total faultless operation of the whole of this composite system. Termination of Nikolaev and Popovich flight shows, how brilliantly this problem was resolved.

A definite and very important side of the reliability problem is the precision in the implementation of all the functions of this system. The proof of the faultless working of the system is the implementation of the planned program and almost simultaneous landing of both the celestial brothers in exactly determined area.

I remember, at the press-conference in Stockhome, when the orbiting, even before the flight of Yu. A. Gagarin, was of spaceship with animals, I was asked, what will happen, if this ship will land outside the USSR territory. I answered this question with assurance, that the spaceship will land, where required. And, as you see, I was right.

Outside the Soviet Union one frequently hears the opinion, that "Yes, in the development of the rocket technique itself the Soviet Union is ahead of USA" (this is being said even by those, who find it hard to admit it). But, besides, it is necessary to compare the efficiency, with which the experiments were conducted with space flights of Gagarin, Titov and, finally, with the last group flight of Nikolaev and Popovich, and this efficiency depended on the quality of instrument equipment, with difficulties, encountered during the takeoff of the American spaceman Glenn, and with difficulties, associated with landing of spaceman Carpenter - in America. This indicates high quality of the whole instrumental equipment, which has assured the precise insertion into calculated orbits, uninterrupted contact and the resulting precision of landing.

What else is remarkable in the carried out experiment? It seems to me, that the noteworthy is the succession, with which we in the Soviet Union are accomplishing the mastering of space, when step by step new problems are being set up, representing development and improvement of preceding achievements, and the purposefulness, with which the idea is being put into practice of conquering the space for the good of all mankind. The whole space research, accomplished by us, is imbued with one object, object of science development for increasing the power of man over nature, uncovering its secrets, so as to make it serve more fully the needs of mankind, and for the sake of this object the flights are becoming more distant and the stay of a man in space longer.

For the sake of achieving the same object, for the sake of the peaceful conquest of the space the Soviet Union is and will continue the struggle for exclusion from the programs of space research those experiments, which may hamper the development of the science, place obstacles to International cooperation in space, those experiments, which contaminate the space. The Soviet Union through U.N. Committee offered to make an agreement about banning the use of artificial Earth satellites for military reconnaissance, on International measures of assistance to incidentally or crash-landed in foreign territory spacemen, on the return of space objects, landed in the same way, to countries, which launched them, but, unfortunately, our partners in the outer space did not welcome these suggestions.

During the last flight of the spacemen critical checking was made of the methods for life support of man in the space flight. The best proof, that the problems connected with it were correctly resolved, is the excellent condition of the spacemen on their return to Earth.

At the same time in already published material and in the address of V.I. Yazdovskii information was given on how far the methods for checking the state of the spacemen during the flight, the processes occuring in the organism, were extended and perfected. The observation data, obtained in this case, will make it possible to produce flights of even greater duration and composition.

Thus the possibility has now been fully proved of prolonged voyages of a man in the space; possibility of a man reaching the Moon and neighboring planets of the Solar system has ceased to be a dream and became a reality.

At a press-conference there is usually the traditional question: what are the next plans of space research in the Soviet Union? Therefore, anticipating this question, I can answer, that the directivity of these plans is known. New efforts will b. applied for further study of the space physics, further research will be conducted of atmospheric manifestations for perfecting the weather service. Space flights will continue initially of automatically controlled interplanetary stations, and with further achievements - with direct participation of a man; work will be conducted on experimental astronomy. As regards making this answer more concrete, permit me to say, that each new success, any new results enable to improve and make more concrete the contemplated plans. Undoubtedly, the last flight of the spacemen, after processing of all the flight material, will permit to introduce alterations, directed toward improvement and may be even expediting the planned research, and in their time new achievements of our science and technique will excite the world.

The courage and selflessness of our spacemen, their devotion to Motherland, readiness to carry out the most difficult assignments of the Party and Government are explained by the composite preparation, which the spacemen received, but mainly and primarily by the inspiring influence of Marxism-Leninism ideas. And this is the main"secret" of our successes in space research.

Our peaceful scientific objects.

Address of the Hero of the Soviet Union pilot cosmonaut A.G. Nikolaev.

Dear comrades! Ladies and Gentlemen!

On the 15th of August 1962 the group space flight of the Soviet spaceships "Vostok-3" and "Vostok-4" was completed.

We, pilot cosmonaut Pavel Romanovich Popovich and my self, had the great honour of commanding these remarkable ships, created by the genius and labour of Soviet scientists, designers, engineers, technicians and workers.

We are living in historic time, when the age-long dream of mankind - space flight - has became an actual fact.

In October 1957 our country has launched the first Soviet earth satellite, in 1961 the first spacemen Yurii Alekseevich Gagarin orbited the Earth on Soviet spaceship "Vostok".

Following this Soviet spaceman Herman Stepanovich Titov completed a 25-hour space flight.

Carrying out the program of communism building, adopted by the XXII Convention of the Party, the Soviet people, CC of CPSU and the Soviet Government pay a lot of attention to the mastering of space with peaceful aims.

It is specially pleasant for me to say, that our space flights are directed twoard the peaceful scientific aims and meet the interest of the whole mankind.

In spite of the extensive information of our press, television and radio about the group flight of the Soviet spaceships during the period from 11 to 15 August 1962, you will, undoubtedly be interested in details of this flight directly from us.

Pavel Romanovich and I are great friends. Together we were getting ready for the flight, together we were in space, and now we will tell you together about this flight. We have mutual understanding and cooperation.

I think of taking up just a few questions, and he will supplement me.

Agreed, Pavel Romanovich?

The spaceships satellites "Vostok-3" and "Vostok-4" are more perfect and comfortable than the "Vostok" and "Vostok-2", on which the first routes into the space were laid by our friends Yu. Gagarin and H. Titov, however the principal arrangement of these spaceships is the same, and therefore there is no need for me to pause on this question.

The construction of the Soviet spaceship and the working of its systems have been sufficiently discussed in the press and reports at various International conferences.

The flight was preceded by two independent stages of preparation, one of which included the general training course of pilots cosmonauts and the second - concrete preparation period prior to the flight.

The general training course includes study of a number of theoretical subjects, special physical, medico-biological, technical and medicinal training. There is no need to mention all types of preparations and training, which we had to undergo. The typical and important types of training we consider the following :

- special preparation, which is conducted on a real spaceship and training devices, which permit to imitate the normal flight and reproduce various failures and emergency situations:

- medico-biological preparation in the form of training on centrifuge, in thermal chamber, pressure chamber, etc.;

- physical preparation.

A lot of attention is being given to flying preparation, including flights on modern fighter-planes and special flights for weightlessness.

The concrete preparation for the flight was conducted in accordance with a special program. The basis of the program were .

- working out details of the flight assignment on a special training device of the type of spaceship "Vostok";

- maintenance of physical training;

- medico-biological investigations;

- flying preparation;

- training in communication, etc.

The details of flight were worked on the training device on each revolution concretly.

Basing on the experience of controlling spaceship by H.S. Titov, we worked on the training device details of the manual control. We trained for exit and entry into seat for the free floating in space cabin. The training device permitted to work out these details of the assignment in full, and during the flight we did not have to think abou' their implementation. We implemented everything, as worked on the Earth. Other details of the flight assignment were worked in the same way.

The availability aboard the spaceship of ultrashort-wave and short-wave receivers and transmitters, providing the possibility of contact between the spaceships, broadcasting receivers and individual means of contact, required for maintaining communication on descent trajectory and after landing, and also interaction with ground control centres required serious preparation in this sphere.

Concrete preparation on these questions and the study of radio transmission program enabled us during the flight to maintain continuous contact between the spaceships and with ground centres. We knew with whom we were in contact every moment of the flight, since it was our comrades spacemen, who were at the flight control centres. The familiar voices added courage, the assurance increased in the carrying out of assignment. We knew, that comrades, having all the data of flight, could help us at any moment.

Flying preparation during this period included flights for weightlessness and working details of landing on parachute with full regular equipment, i.e. in space suit and with emergency supplies and radio set.

Physical preparation and observation by doctors of our health were conducted daily. The concrete purposeful preparation enabled us to carry out successfully the flihgt program.

As you know, I tookoff on the spaceship "Vostok-3" on the 11th of August 1962 at 11 hrs 30 min Moscow time and successfully entered the prescribed orbit, which, by the way, was very close to calculated one.

The initial orbital period of "Vostok-3" was 88.5 min. The perigee and apogee distances were 183 and 251 km respectively. Orbital inclination was 65°.

My celestial brother, Pavel Romanovich Popovich, took off the next day, i.e. the 12th of August 1962, at 11 hrs 02 min Moscow time on spaceship "Vostok".

It is really admirable, that spaceships "Vostok-3" and "Vostok-4" were inserted into prescribed orbits with exceptional precision both in time and place.

After the orbital insertion of "Vostok-4" our spaceships were close to each other and we were ready to shake hands and congratulate each other with the first successes.

The considerable orbital inclination enabled us to enjoy the view of all the continents on the Globe.

The main problems, which were being resolved by our first group flight, were the following:

- obtainance of additional data on the effect of space flight on human organism;

- efficiency investigation of a man in conditions of weightlessness;

- carrying out by a man of a certain amount of research during a space flight;

- further improvement in communication, control and landing systems of the spaceship;

- obtainance of experimental data on the possible establishment of direct contact between spaceships in group flight, action coordination of spacemen, checking the effect of similar conditions of space flight on human organism.

We were very pleased to report to the CC of CPSU, Soviet Government and to the whole Soviet people, that the assigned problems were successfully resolved. The planned flight program has been completed and successful landing implemented in the preset area on the territory of our Motherland - the Union of Soviet Socialist Republics.

During the 95 hrs, i.e. almost four days I have orbited on spaceship "Vostok-3" the Globe over 64 times and covered a distance of 2 million 600 thousand km.

What can be said about my impressions of the flight?

You can understand - it is not an easy problem. The flight, as I have mentioned, lasted 95 hrs and to describe the impressions of this flight will require just as much time. We do not have this time. Therefore I will have to describe only the main impressions of the flight.

The spaceship "Vostok-3" was a home for me during the four days. I felt the warmth and care of the Soviet people, Party and Government and this care multiplied by strength tenfold. I was touched to the bottom of my heart, just as my friend Pavel Popovich, by the greetings messages. It brought new energy, increased the will for victory.

Throughout the flight I had a steady assured contact with the Earth, I heard the voices of my friends-spacemen, who communicated the necessary data.

And what a happy feeling I experienced, when at the end of the first day of my flight, when into orbit next to me entered spaceship "Vostok-4", manned by my friend and, as it being said now, space twin-brother Pavel Popovich. We at once established a two-way radio-contact, inquired about the health and wished each other happy flying.

It is difficult to convey, how good it is to fly together in space, to feel a friend next to you. Our flights were going on exactly according to plan, which was developed on Earth, as it is said, minute per minute. Each detail of the flight assignment was worked out and well prepared on Earth. We worked according the principle : "Hard in training - easy in flight".

Getting ready for the several-days space flight, I realized, that I and Pavel Popovich, who was taking off the next day, will have to answer scientists to many vague questions, connected with the effect of space flight on human organism. I assumed, that I will feel discomfort, due to reaction of vestibular apparatus to weightlessness. However neither at the first revolution, nor to the end of the four-day flight no unpleasantness what ever from the vestibular apparatus was experienced by me or by Popovich. Moreover, conducting for the first time in space vestibular tests, I was very careful, tried to implement all the prescribed turns of the head, movements of eyes in exactly envisaged volume. But not feeling any unpleasant sensations I began to increase the effect on vestibular apparatus, making tens of times quick turns of the head to either side, moved along the cabin in different directions, rotated around my longitudinal axis in free soaring - the result was just the same: no unpleasantness whatever.

Pavel Romanovich was right, when he said, that our vestibular apparatuses were "dampened". In pilots of spaceships "Vostok-3" and "Vostok-4" there were no vestibular disorders throughout the flight. We did not suffer also from loss of appetite. We took our meals exactly according to time-table.

The food was varied, it was selected in accordance to our tests. We always ate with appetite. Always before breakfast and lunch we wished each other "good appetite", spoke of what each like the best. He said, that he likes vobla (dried and salted roach). I said, that I am having one now, although I did not have it.

The water in spaceship was tasty - fresh, cool Moscow water and I drank it with more pleasure than the various juices.

I always slept well. Six hours of sleep was quite enough for me, but I had to make it upto eight in accordance with the plan. It is interesting, that the first night I woke up about three times, the second, third and fourth night woke up without the alarm clock at 2 o'clock in the morning, whereas I had to get up at 4 o'clock. I looked at the time and went again to sleep. How well I could sleep.

Interesting also is the fact, that I woke up regularly at 4 o'clock. The second day at two minutes to four, the third - exactly at four. I was surprised myself, that I could get up at fixed time without the alarm. But on the last - fourth day I overslept by ten minutes and instead of being above our territory, I was above the North America.

The observations were very interesting. From my space rocket very clearly visible were the coast lines, outlines of cities, specially at night due to illuminance. The boundaries could be determined of cities, main streets. Thunderstorms on Earth were clearly seen at night.

During our flight there was a full moon. The Moon is very beautiful, just as we see it from the Earth, but here it is clear, that the Moon is a sphere. When I saw the Moon for the first time I was very happy, as I had the camera and wanted to photograph the Moon. The first time I was in a hurry, but during the following days photographed it several times. When we entered the shadow of Earth, the Moon always gave us light. Even at night with the lights off the cabin was so light, that even the instruments could be distinguished.

I saw the Orion constellation. All of you are probably familiar with it. It is characterised by a belt of three stars. I told Pavel Romanovich, that in the right-hand porthole I can see Orion. And indeed! At the same time he also saw the Orion constellation.

I had my time-table. I have been doing physical exercises. These were specially worked out on Earth specially to keep up the muscle tonus. On the last, but one day I exercised intensely, to get my organism fully ready for overstrain.

The last revolution was most interesting. When all the systems of the spaceship, all the instruments for descent were switched on, the heart felt lighted. I was thinking, that after a while I will be on the Earth. I told about it to Pavel Romanovich, informed him, that everything is switched in and everything normal. Then after six minutes he told me, that everything has been switched. At the end of the fourth day the distance between our spaceships was a six-minute flight. After the brake motor was started and began operating, I felt even happier. After the operation of the brake motor the spaceship separated, and there began the descent itself.

I would like to describe this descent in detail. When the spaceship began its descent, the overstrain was low. Further on they were increasing vigorously.

The most interesting moment is, when the coating begins to burn. First there is a little smoke (everything can be seen through the porthole), then a flame of various color, and by the way, not of the same color, but red, orange, yellow, green - different colors of the flame. During the maximum overstrain there is a high compression. I expected these over-strains, knew, that they will be, on Earth we trained on the centrifuge. It seems to me, that without the training it would have been more difficult. It was because of that training, that I could stand all the over-strains.

It is interesting, when the burning begins. Loud crackling can be heard. One thinks, that a piece of coating will break off. But I know the construction of the ship and should not have these doubts. I am telling myself: "Calmly, let it burn, there is normal descent".

When the overstrain begins to decrease there is a feeling as though one travels in a cart along a bad road: the shaking is intense. Then gradually with the drop of velocity the shaking also decreases. The overstrain begins to decrease. It is quite easy, when the peak of over-strain is passed.

Thereafter I descended on parachute, separated from the ship, landed in the vicinity of Karaganda. The first feeling is that one wants to kiss the ground of our Motherland.

According to time table we worked, conducted observations and rested. I must confess, that sleeping in the space is very good. Nothing presses anywhere, there is no need to turn from side to side. True, this lightness, connected with weightlessness, no necessity to make physical efforts may specify reduction in the required muscle tonus and this is quite undesirable with return to Earth. You see, after the complete muscle weakening considerable effort is required from the spacemen to withstand the over-strain, arising with the entry into atmosphere, and for safe landing. This is why both my friend Pavel Romanovich and myself carried out with pleasure the physical exercises, prescribed by the program. This kept up not only the muscle tonus, but also the efficiency.

The successful implementation of the flight is assured by corresponding technical equipment. You cannot get far with wish and enthusiasm alone. And although a lot has been said about our space technique, I cannot avoid saying a few words myself. There is an expression - "clever machines". Spaceship is a very clever machine. And these clever machines were created by our Soviet people. With familiarity, mastering and usage of our space technique the feeling of pride and admiration for our scientists, designers, engineers, for our workers, who create spaceships never leaves us.

A spaceship is a concentration of everything advanced, new in the science and technique. In particular I would like to emphasize, that our designers pay a lot of attention to safety of the flight. This is quite natural, as a man is the most valuable thing in our country. Our flights have once more convincingly shown, that every system of the spacehip operates correctly. On the whole our spaceships assure implementation of the most diverse tasks in space. One more practical examination has been passed. The present flights of "Vostok-3" and "Vostok-4" will enable our talented scientists and designers to construct even more perfect and powerful spaceships, which will make it possible for our pilots cosmonauts to resolve even more complex problems.

With your permission this will conclude my narration. Thank you for your attention.

<u>The first Soviet group in space.</u>

<u>Address of the Hero of Soviet Union Pilot Cosmonaut of USSR P.R. Popovich.</u>

Dear comrades! Ladies and Gentlemen!

It is a great pleasure to me, just as it was to my celestial brother Andriyan Grigor'evich, to tell you, representatives of the press, about the first in the world group flight of Soviet spaceships.

We, the Soviet pilots cosmonauts, are glad, that the spaceships, on which we accomplished group flight, are a wonderful creation of our Soviet science and technique.

We are also glad of the fact, that we have composed in space the first Soviet collective body.

You all know, that my friend Andriyan Grigor'evich and myself, before becoming spacemen, were pilots. This is quite natural, as the pilots in their training, knowledge, health, endurance and other qualities are the most suitable for the first flights on spaceships.

The construction of the wonderful ships and preparation for the space flight were being implemented by a body of scientists, engineers, technicians, workers, fliers, doctors and other specialists. Their selfless labor assured the success of our flight.

It should not be thought, that the space flight was a picnic for us. This is a unique job, involving quite a lot of work and requiring excellent preparation and health. Therefore, prior to the flight we had to do a lot of work on the ground. The fact should also be mentioned, that Andriyan Grigor'evich and I with our doubles had a lot more time to prepare for the flight, than Yurii Alekseevich and Herman Stepanovich, and then we used their experience.

We are glad, that the planned program of research on spaceships "Vostok-3" and "Vostok-4" was completed in full.

I was in space for 71 hours and could have continued the flight, as I was feeling quite fit and the systems of the spaceship operated faultlessly. But assignment is assignment.

In space I did everything just as on the ground: worked, as provided by the flight program, enjoyed my meals, carried out physical exercises, slept soundly without any dreams.

My opinion regarding the joint flight of two spaceships is the same as of my friend. Each one of us felt the other at the elbow. This gave one a happier feeling and the work progressed better.

Some gentlemen byond the ocean attempted tc deny our flight and demand proof, that we actually have accomplished this flight into space. What can be said to these people? Takeoff into space, gentlemen, follow us, catch up with us to see, how the Soviet spaceships fly.

It goes without saying, that flying two together in space is more cheerful than alone.

Imagine, how glad I was, when after entering an orbit I could hear in the earphones:

"Hawk, Hawk, I Eagle, can hear you clearly. How are you? Out". I was so happy I forgot all the rules of communication and said: "Andryusha, can hear you clearly, I feel fit. Can see you".

Knowing, where the spaceship "Vostok-3" should be in relation to me, I after insertion into orbit watched it, which appeared as something in the shape of a small Moon.

We maintained regular contact. Andriyan Grigor'evich transmitted to me by radio his experience, since some details of the flight he has already implemented during the first day. For instance, he informed me, that he already has been out of the harness and freely floated in the cabin. I have also done it successfully. And what a feeling I experienced! I weighed nothing, you understand, could freely move along the cabin, rotate around my axis. I felt wonderful.

During the flight we spoke to each other about the way we felt, exchanged opinions and impressions about everything we've seen in the space, and even, as you know, sang in duet our favourite song: "The space maps are filled into the case...".

Looking at the Earth we could clearly see towns, rivers, mountains, ships, etc.

The continents are clearly distinguishable. From different colors and outlines it is possible to judge above which continent we are flying, where is the shore line. The islands are framed in a halo, resembling the color of emeralds. All the islands are clearly seen from space, just as the rivers and roads, Our planet is altogether very beautiful. It is pale blue, wonderful horizons open out, specially with the entry into and exit from the shadow.

Andriyan Grigor'evich have said, how the Moon impressed us. We were lucky in that it was a full moon. Therefore we could see our satellite in all its beauty.

During the flight I had to carry out many scientific experiments. In particular, I can speak of the behavior of water in space. On Earth if the flask is filled with water not up to the edge, part of vessel will be filled with water, part with air. In space it is different - the water is at the top and at the bottom, whereas the air is in the middle in the shape of a sphere. And it is like that all the time. It can be shaken, but again it will gather in the centre into the same sphere.

During the flight I often observed luminescent particles, which flew very smoothly past the ship. These particles were observed also by Gagarin and Titov. These particles are the usual waste products of the engine.

Andriyan Grigor'evich has mentioned, that we did not suffer from loss of appetite in space. The specially prepared food consisted of natural products, packed into tubes and plastic bags. The food was delicious and our individual tastes were taken into account. With this ration one won't perish even on the Moon.

Excellent conditions were created in "Vostok's" cabin. Air-conditioning system provides microclimate the same as on the sea-coast: pure air, normal pressure and humidity. The temperature in the cabin could be adjusted as desired. These conditions made it possible to carry out the flight assignment without drop in efficiency throughout the whole flight. We were feeling quite fit in the space and cheerful every minute.

It was pleasant to realize, that our space trips have scratched out the pessimistic assumptions of some Western scientists, that a man cannot exist for more than 24 hours in space and that the prolonged weightlessness could prove to be the unsurmountable barrier to the mastering of space by a man. In their opinion the spacemen could only be those persons, in whom the vestibular apparatus is destroyed by operation or any other means. Our group flight has given a positive answer to the question, as to whether a man can exist and work in space for several days.

We are firmly convinced, that a time will come, when the scientists, designers, spacemen of different countries will join their efforts. This will permit to resolve problems, which are now only a dream. There is no need to say, that the sooner this time will come, the better it will be for all the nations of the Earth.

What can be said about a man's work in space?

Our many-days flights have shown, that a man's efficiency on a spaceship is not lower, than on a plane. A man in space can work successfully, control the systems aboard the spaceship. These flights have shown, that a man aboard a spaceship can fully and efficiently work.

Data of our group space flight are being now correlated. After the flight we feel fit and ready to carry out new assignments.

Thank you for your attention.

"Pravda", 22 August 1962.

THE FIRST IN THE WORLD GROUP FLIGHT IN SPACE. (Main results).

1. The tasks and program of prolonged group flight.

The first in history man-in-space flight of Yu. A. Gagarin on spaceship "Vostok" on the 12th of April 1961 was the first experience of a man's direct penetration into space. Data, obtained during this flight, in spite of its short duration, permitted to make a number of important conclusions regarding the man's capacity to endure normally conditions of space flight, conditions of orbital insertion and return to earth surface: valuable information was obtained on performance of the ship's construction and of the whole complex of systems and instruments aboard and on the ground.

Positive results of this flight made it possible to begin preparations for the next step on the way of a man's conquering of the outer space - preparation of a 24-hour flight into space. This flight was accomplished by the second Soviet spaceman H.S. Titov on spaceship "Vostok-2" on the 6-7 of August 1961. During the 25-hour flight H.S. Titov completed 17 revolutions around the Earth and safely returned to the Earth. The prolonged weightlessness, orbital insertion and descent did not affect the health state of the spaceman. During the whole flight he retained his efficiency and felt fit. Only some disorders were noted in vestibular apparatus of the spaceman.

From the analysis of these disorders it was assumed, that reactions of human organism to flight conditions are determined mainly by the physiological system of space analyzers (vestibular, visual, motor, etc.). The obtained data indicated, that in conditions of weightlessness disturbances were possible in the interaction of space analyzers and changes in the sensitivity threshold of vestibular apparatus. And this in turn may result in the fact, that even insignificant in intensity vestibular stimulus may induce symptoms, resembling sea-sickness.

In the next flights it was going to be elucidated, whether the noted departures are the result of certain conditions of a given flight, or the result of individual characteristics of the spaceman's organism. Of great practical interest was the question about the unavoidability of these manifestations with prolonged weightlessness.

From this point of view it was very important to have the flight carried out simultaneously by two spacemen. This would enable to compare the effect of similar conditions on different human organisms.

The results of the first flights of Soviet spacemen, positive data on the construction of their spaceship and performance of the set of instruments, obtained in these flights, enabled to make a new important step in space research - prolonged group flight of two Soviet pilots cosmonauts on two spaceships.

In this flight it was planned to conduct investigations and experiments, required for resolving a number of new medico-biological and technical problems.

The most important problems in the sphere of the medico-biological investigation in this flight were the following:

- possibility of considerably increasing the duration of manned space flight;

- effect of prolonged space flight and specially of weightlessness on the main physiological functions of a man, peculiarities in the daily periodocity of physiological processes of human organism in this kind of flight.

The most important technological problems set for this flight were the following:

- checking and operating spaceships "Vostok" in conditions of prolonged flight;

- operating complex for the orbital insertion of the second spaceship in immediate vicinity of the earlier orbiting first ship;

- practical checking of the possible establishment of direct radio-communication between the two spaceships during their flight at different distances from each other:

- working out complex for the ground control of several spaceships in near-by orbits.

Resolution of these problems is of great significance for further development of the space and rocket technique.

There was also a number of other tasks: carrying out by spacemen individual experiments during the flight, biological experiments, observations of adjacent spaceship, checking of the spaceship's equipment in flight, checking of communication, orientation systems, etc.

The preparation for the flight and working out of the flight program were based on these problems.

The instruments and construction of the spaceships were additionally worked over to ensure the possibility of the group flight, enhancing comfort in the space cabin and improving the individual equipment of the spacemen.

The flight program envisaged insertion of spaceships into orbit at an interval of one day. Moreover both the spaceships had to takeoff from the same launching pad. Takeoff time of the second spaceship had to be fixed with an estimate of the actual orbital parameters of the first spaceship, so that after the insertion the second spaceship would be in the immediate vicinity of the first one.

The group flight was planned for three days. The landing was to be in Kazakhstan. With normal flight according to program the landing was to be automatic on command from the Earth.

In case of the spaceman not feeling well or departures in operation of the instruments the possibility was provided for emergency landing during any period with the use of automatics or hand control if the spaceman wishes.

The flight program determined also the working order of the ground complex of control, measurements and communication during the flight of the spaceships.

The flights assignments to spacemen were composed in accordance with the program and the objects of the flight. The following tasks were set to spacemen in flight:

a. To get into contact on ultrashort channel of radio-telephone system with ground centres on the territory of the Soviet Union. To contact Earth on short-wave channel once every hour, except during the time, allotted for rest. To contact the adjacent spaceship every half an hour, calling each other by turns. Receive ground transmission by means of broadcasting receiver.

b. To carry out regularly psychological, physiological and vestibular tests, conduct medical checking of one self (pulse, respiration rate, endurability of noises, vibrations, overstrain, weightlessness, appetite, efficiency, sleep). To evaluate the convinience of sanitary equipment and hygienic conditions in the cabin (illumination, purity of air, temperature, humidity). To estimate any peculiarity in taking food and its quality.

c. To orient the spaceship by means of manual control in order to observe the adjacent spaceship, Earth surface, celestial bodies, etc. To appraise the convenience of using manual control and its effectivity.

d. To carry on observations through the portholes directly and by means of binoculars. To observe the Earth surface, horizon, specially with the entry into and exit out of the shadow, the Moon and the stars. To observe as much as possible the adjacent spaceship. To conduct filming through the portholes, selecting subjects and time of filming at the discretion of the spaceman. To conduct filming inside the cabin by means of a special cinecamera.

e. In the case of the spaceman feeling well to get released from the harness on the 4th revolution of the first day and on second revolutions on the following days and to freely float in the cabin for 50-60 minutes each time. In this case the convenience had to be estimated of being in the state of "free floating", possibility and quality of orientation in space, pose with the weakened muscles, convenience of shifting around the cabin, etc.

f. To regulate atmosphere parameters in the cabin, to control performance of equipment.

g. To conduct biological experiments.

h. To take meals during the flight four times a day: breakfast - at 5-6 a.m. (Moscow time), second breakfast - at 8-9 a.m., lunch at 14-15 hrs and dinner - at 20-21 hrs.

i. The results of observations and implementation of the flight program to be recorded in log book and by means of tape-recorder.

In case of illness to inform immediately flight control.

The above-stated facts show, that the flight assignments envisaged a quite strenuous program of the spaceman's work in flight.

The accomplishment of the group flight required resolution of some new technical and organisational problems. These included:

- preparation of the whole ground complex for flight control from the Earth of the two spaceships, trajectory control, telemetric measurements, radio-telephone communication with spacemen, reception of TV pictures from aboard the spaceships;

- preparation of technical means and personnel for simultaneous and quick processing of all received information;

- organization and preparation of service for the search and evacuation of spacemen in the case of their landing in non-estimated area;

- organization of service and preparation of means for the forecasting and quick control of radiation at flight altitudes of the spaceships;

- organization of continuous medical checking of the spacemen's condition in group flight on the basis of all the information, received on communication, telemetry and television channels.

All these problems were successfully resolved during the preparation and implementation of the group space flight.

II. Construction specifics of the spaceships.

The spaceships "Vostok-3" and "Vostok-4" are controllable spacecrafts. Each spacecraft consists of hermetic cabin with the spaceman, instrument compartment and braking motor compartment.

The cabin on the outside has a special thermal insulation, protecting it from high temperature in descent trajectory.

The shell of the cabin has three portholes, through which the spaceman can conduct observations. The portholes are provided with heat-resistant glass and protective shutters, which can be closed and opened both by electric drive and manually.

Arranged in the space cabin are the life support system, supply of food and water, control equipment, part of radio-equipment, TV cameras, binoculars, cinecamera, spaceman's seat.

The instrument compartment contains radio equipment, control instruments, thermal control system.

During the flight the spaceman, dressed into space suit, is in the ejection seat. During the descent from orbit the space man can either land in the cabin, or get ejected at low altitude and land separately from the spacecraft on parachute. Landing on parachute has a number of advantages, when it is on land, where the landing conditions could be complicated by topography, wind, etc. Therfore in group flight, just as in the flight of spaceship "Vostok-2" the possibility was provided. If the spaceman wished, or landing separately from the spaceship. It should, however, be mentioned, that in all the flights (including the last group flight) the landing system of the spaceship also operated normally, and the ships were landing safely.

Usually during the flight the spaceman is fixed in the seat by means of a harness. In the preparation for group flight the harness was adjusted in a way to enable the spaceman to leave the seat for experiments in free floating in the cabin.

The space suit is ventilated by the cabin air. In case of cabin's dehermetization there should be automatic hermetization of the space suit. The supply of oxygen to the spaceman and ventilation in this case would have been from reserves of compressed oxygen and air available on board. The supply of oxygen and air give a chance to the spaceman in the case of the cabin's dehermetization to get in contact with the Earth, to decide on what is to be done, to select the place for landing and to descend. The construction of space suit was additionally worked on with the object of increasing comfort.

The equipment for manual control of flight and descent enables the spaceman to orient the spaceship himself and to implement, according to his own discretion, landing of spaceship in an area of his own selection.

The automatic orientation system assures a certain attitude of the spaceship and automatic programmed implementation of all the operations prior to switching of braking motor.

The braking motor with corresponding control system is meant for changing magnitude and direction of velocity with the object of transferring spaceship from the orbit to descent trajectory. The cut-in of braking motor could be automatic (with the use of automatic landing control), and manual by the spaceman with the help of control members, fitted on the control board in the space cabin.

Radio equipment of the spaceships is meant for a two-way radio-telephone and telegraph communication between spaceman in a short-wave band, two-way radio-telephone and radio-telegraph communication of both the spaceships with ground stations in short-wave and ultra-short wave band, radio measurements of the orbital parameters, transmission to Earth of telemetric information, as well as TV picures from aboard the spaceships.

The space cabin contains also a tape-recorder and receiver for broadcasting programs.

Air-conditioning system was used for maintaining gas composition and humidity of air in the cabin. Thermal control system maintained normal temperature and pressure.

In order to increase the volume of information on the state of the spaceman during the flight additional equipment was carried on the spaceships for measuring electric conductivity of the skin, cerebral bio-currents and movements of eyes. There were also dosimeters for measuring radiation and individual dosimeters.

III. Control and measurements in group flight.

For measurements of orbital parameters, reception and recording of telemetric and television information, provision of two-way radio communication and control, a ground complex was used, equipped with radio aids. The network of the observation stations of the complex is disposed on the territory of the Soviet Union in a way, that it enables to carry out measurements and maintain contact with the spacecrafts at a maximum possible number of revolutions, which passed through the territory of the Soviet Union.

Radar stations provided for the measurements of orbital parameters of both the spaceships, when the latter were in the "radio-visibility" zone of the stations. By means of special computers the obtained information was converted into binary code, averaged, tied to astronomical time and automatically issued into communication lines. By means of input devices at computing centres these data were punched on punch-cards and put into digital computers. Processing of information received from radar stations was implemented at Coordination centre. It assured estimate of the actual orbital parameters of the spaceships, forecast their orbiting several revolutions ahead and prepared target indication for ground stations. To eliminate possible errors in estimate the mathematical processing of incoming information was implemented on several computers in parallel. The correctness of obtained results was checked by statistical analysis methods.

The radio-telemetering stations received and recorded telemetric information transmitted from aboard the spaceships. Telemetric information included physiological data of the spaceman; temperature, pressure, humidity and composition of air in the cabins; data, characterizing the state of the outer space, data on performance of systems and equipment of the spaceships, etc. Signals, carrying telemetric information were recorded, then decoded by means of special devices and analyzed.

Radio-television stations received and recorded pictures of spacemen and individual elements of space cabins. For the first time in the world pictures of the spacemen were broadcasted by the Moscow telecentres and then by Intervision and Eurovision.

Ground radio-stations of the complex provided two-way radio-communication of the spacemen with Earth. The tasks of the ground complex included also the takeoff moment determination of the second spacecraft. In accordance with the orbital parameters of "Vostok-3" the coordination centre determined the takeoff time of "Vostok-4" on the estimate of inserting it in the immediate vicinity of the first spaceship. And at the indicated time "Vostok-4" took off from the same launching pad. After orbital insertion "Vostok-4" was found to be, according to confirmed data, at a distance of 6.5 km from "Vostok-3".

In the case of the spaceships landing in non-estimated area a special service was organised for the search and rescuing the spacemen.

To simplify this problem aboard the spaceships, and also with spacemen were special bearing transmitters, operating in short and ultrashort-wave bands. They were switched on after the landing.

The composition of ground service included a network of direction finding points. They issued coordinates of spaceships during their descent and coordinates of the spacemen immediately on their landing to the search and rescue service. This service had at its command a large number of planes and helicopters, equipped with direction finding receivers and means for communication. Also sea-going ships, etc.

IV. Radio and TV communication with "Vostok-3" and "Vostok-4".

The spaceships "Vostok-3" and "Vostok-4" carried a set of radio-equipment for communication, based on the previously tested equipment of "Vostok" and "Vostok-2". The set was composed of three two-way radio-telephone lines - two in short wave band and one in ultra-short. Besides this there were on board tape-recorders, broadcasting receiver with medium and short wave bands. The transmitters had quartz frequency stability.

The receivers on board were constructed on superheterodyne circuit with double frequency conversion and quartz stabilization. They operate fully on semiconductors. Power, consumed by these receivers is so low, that it would not be enough for a bulb of pocket torch. The sensitivity of receivers corresponds to the most rigid standars of radio-communication equipment and is upto the millionth fractions of a volt.

The spacemen had four receiving channels - ultra short-wave, distant short-wave, inter-ship and broadcasting. The main working condition was listening in to distant short-wave and intership channels, moreover each of these the spaceman listened to with one ear. In operations on ultra short-wave the inter-ship channel was off, and with the cutout of the ultra short-wave channel it is automatically switched again. The broadcasting reception the spaceman could have on the telephone, then the short-wave channel was disconnected or simultaneously with reception on short-wave channel the broadcasting receiver could operate on its own loud speaker. Besides this loudspeaker, each telephone was duplicated by individual loudspeaker, so that if the spaceman wished he could disconnect the telephones and change over to reception from the cabin's loudspeakers. This enabled the spacemen to carry on "observational" reception on three channels and to "rest" their ears. With this reception the atmospherics have less effect on the spaceman's hearing, and he is in more favourable circumstances, than with reception on telephones, although the sensitivity of this reception is, naturally, lower.

The broadcasting receiver is also made on semiconductors in superheterodyne circuit. It has smooth tuning, including broadcasting short-wave bands (25, 31, 41 and 49 meters), and medium wave band from 190 to 580 meters.

The tape-recorder on board is provided for the spaceman's convenience with automatic start, due to which the tape-recorder begins to operate, as soon as the spaceman begins to talk. On completion of taking the recording automatically stops. The tape-recorder may also be controlled manually by means of a switch on control panel.

Indicator of recording is a minute neon bulb, which blinks in tact with the spaceman's talking and shows, that device is operating normally. When on command from Earth the tape-recorder operates in accelerated reproduction, the bulb begins to blink correspondingly faster, signalling to spaceman, that the tape-recorder is operating automatically. With the need to transmit at this time any urgent message the spaceman can do it by pressing of a special key on the control board - during the transmission of the massage the tape-recorder will stop and at the end of the talk will automatically resume the reading.

On spaceships "Vostok-3" and "Vostok-4" the spaceman could also use Morse key on all the communication transmitters and on telemetric trnsmitter "Signal", in which case a special device automatically disconnected transmission of telemetry and at the end of operation with the key again connected "Signal" and telemetric transmitters.

For radio-communication between the ships it was decided to use one of the short-wave bands.

Radio-communication between the spaceships was very stable and clear at all distances, starting from 6.5 km (minimum distance between them) and upto maximum, which at the end of the flight was about 3 thousand km.

Simultaneous flight of the two spaceships has set new problems in organising and conducting communication. It required enormous work to accomplish transmission from the Earth to spaceship and reception of the spacemen's transmission from any point on the territory of the Soviet Union through the ultra short-wave station, which has the contact at the given time with the spaceship. This enabled to converse with the spacemen from one point throughout their flight above the USSR territory, so that quite often the two-way conversation with spacemen on ultra short-wave were conducted by operator, who was at a distance of several thousand km from them.

The ground short-wave transceiving centres are composite modern erections with multi-kilowatt transmitters, a great number of directed antennas and scores of main receivers.

All conversations were recorded on tape-recorders. Messages aboard were transmitted through radio-centre, which assured optimum passage of radio-waves in accorance with ionospheric forecasts. Reception of messages from spaceships conducted simultaneously by a number of radio-centres with the use of powerful directional antennas, changed-over according to target indications, continuously incoming at radio-centres from coordination centre. All this required very efficient and quick work of receiving and transmitting short-waves of radio-centre.

Communication on short-wave band was very successful both on the main "Earth-spaceship-Earth" radio-lines, and in listening on Earth to radio-line "spaceship-spaceship". Maximum distance of communication was upto 12-20 thousand km, whereas distance, exceeding 10 thousand km, was quite usual.

The prolonged flight program enabled the spacemen to leave their seat and free float in the cabin. In this case they could not use the microphones and telephones of the space suit, which became disconnected. They had to conduct radio-communication by means of a special system of the cabin's loudspeakers and microphones. This system was arranged in a way, that with the spaceman being at any point of the cabin the audibility of transmissions from the Earth and the loudness of his transmissions remained practically invariable.

The spacemen often listened to broadcasting programs, especially during the rest time, which used to fally, invariable, at the southern hemisphere. There was good audibility and a lot of static s being received. The interesting fact is, that the spacemen received a number of broadcasting stations in 200-300 metres medium-wave bands.

The considerable duration of the flight and intensity of the radio-exchange of spacemen with the Earth enabled to accumulate an exceptionally valuable data on the passage of radio-waves and organization of radio-communication simultaneously with two spaceships. This will permit in future to plan an even more perfect equipment for radio-communication with the next spaceships and to ensure organization of contact with any number of spaceships in flight.

In group flight of "Vostok-3" and "Vostok-4" the problem was of direct transmission of picutres from aboard the spaceships for millions of viewers of the central TV system of the Soviet Union and Intervision and Eurovision systems.

Technically this difficult problem was resolved in the following way. Each spaceship carried two TV cameras. One provided a large-scale picture in face, the other - smaller - in profile. This slection of optics and arrangement of TV cameras made it possible to obtain the most complete information on the state of the spacemen.

The TV cameras were made on vidicon television pickup tubes and were of small dimension, low weight and energy consumption, but of high stability, providing for many-days high quality performance without any adjustments.

The TV signal was fed into powerful transmitter and through the ship's antenna-feeder system was transmitted to reception points on the ground. In order to improve the power conditions of radio-line with minimum weight of the set and low power consumption, the parameters of the TV system "ship-Earth" were selected very much different from standard parameters. The number of pictures was reduced to 10 per second, number of lines - to 400 in a picture with progressive scanning. This ensured narrowing of the videosignal spectrum to 500 Kcps instead of 6-6.5 Mcps with standard parameters.

The reception on the Earth was by means of high-sensitivity receivers and antenna erections with relatively high effective area. At the reception stations the pictures were recorded and viewed on video-checking devices. Naturally, pictures received in this way were not suitable for direct transmission in broadcasting network. To resolve this problem the reception stations had equipment transforming pictures from aboard the spaceship into standard form.

From reception centres the transformed pictures were transmitted along the radio-relay and cable lines to Moscow television centre and hence in the usual way were translated within the Soviet Union and into scores of countries abroad.

Thus, for the first time the multi-million audience of earth viewers had the possibility to observe directly the "space week-days" of our hero-spacemen Andriyan Nikolaev and Pavel Popovich, to see with their own eyes the phenomena of weightlessness, to "participate" indirectly in this grandiose experiment.

V. Assuring radiation safety.

The effect of penetrating radiation is one of the main factors, determining the possibility and duration of space flight in a certain orbit.

In flight the spaceman is subjected to irradiation by cosmic rays, incoming from the depths of Galaxy and from the Sun, as well as by electrons and protons of the radiation belts.

Usually the doze of radiation by cosmic rays in the vicinity of the Earth beyond the atmosphere is comparatively low - it exceeds only hundred times the cosmic back-ground at the sea level and varies from 1.5 to 15 milliard per day, depending on the latitude of the spacemen's position. This radiation intensity is not above the tolerance limit as fixed for persons, continuously working with ionizing radiation.

The spaceman during the flight is affected also by the rays of the radiation belts of the Earth, consisting of charged particles, captured by the Earth's magnetic field. Getting of spaceship into some of the regions of these belts, specially into central areas at an altitude of 1000 km in the vicinity of equator, is in some conditions very dangerous, due to high irradiation of the cabin and the spaceman.

The flight path of spaceships "Vostok-3" and "Vostok-4" were selected such that the rays of the Earth's radiation belts composed only a small part of the total doze, which the spaceman could get. Lower boundaries investigations of the Earth's radiation belts, conducted by Soviet scientists in 1960 on spaceships of "Vostok" have shown, that in flights at altitudes 180-350 km the radiation belts are hardly touched, and the average doze in the pilot's cabin composes only 8 milliard per day. This is not dangerous for health.

However sometimes the intensity of cosmic rays in the outer space sharply rises upto dangerous level. As a rule, these intensity increments of cosmic rays are connected with chromspheric flares on the Sun, during which the Sun ejects into ambient space an enormous amount of high-energy protons.

After considerable solar flared the intensity of cosmic rays at great distances from Earth outside the magnetic field increases thousands and even scores of thousands times. This results in enormous increment of dozes, upto lethal levels of about 500 rad.

In the vicinity of the Earth at altitudes of about 300 km radiation intensity at various points of the Globe increases differently. This is because the charged particles with movement in magnetic field deviate from the initial direction of their motion. If the velocity of particle is low, and the magnetic field is of high intensity, the particle may change its motion in reverse, as though repulsed from the magnetic "wall". Therefore only those particles may get to Earth, the energy of which is above a certain critical energy.

Particles, ejected by the Sund during the chromospheric flares, can reach, as a rule, the upper atmospheric layers only at quite high latitudes in the vicinity of the Northern and Southern poles of the Earth. In these regions solar flares of high power may result, just as in the distant outer space, in serious irradiation injury to the spaceman.

Therefore one of the problems in ensuring radiation safety is the forecasting and recording the onset of dangerous in respect of radiation solar flares. To forecast solar flares the use is made of the optical observations of the Sun, which are conducted by extensive net work of heliophysical stations and astrophysical observatories on the eve of and during the space flight.

This forecasting is based on the following facts. Surface regions of the Sun, close to which occur high chromospheric flares, are characterized by magnetic fields of very high intensity. The intensity of magnetic fields at these points exceeds thousands of times the intensity of magnetic fields in the adjacent calm areas of the Sun's surface. It is found, that appearance of the flare concommitant with ejection of high energy particles, is connected with some definite forms of these magnetic fields. It was found, that these active sections of the solar surface are the sources of powerful radiation impulses in centimetre and decimetre bands. This radiation is recorded also by the network of ground stations and enables to verify the onset of solar flares. Thus, observations of the solar activity at moments prior to the flight and during the flight makes it possible to forecast flares of the solar cosmic rays, of danger to the spacemen's health.

Besides the optical and radio-astronomical observations of the solar state, immediately prior to the flight and during the flight of the spaceships "Vostok-3" and "Vostok-4" direct intensity determination was conducted in the upper atmospheric layers by means of balloons, the flights of which were being carried out several times a day in different areas of USSR, including polar regions.

Cosmic radiation, solar flares and radiation belts of the Earth are the natural sources of dangerous radiation.

The task of the scientists is to study thoroughly these sources, so as to ensure by sensible means safety of space flight at great distances from the Earth. Unfortunately, besides these natural sources of radiation, there are also others - manmade. These are the artificially created in the vicinity of Earth as a result of nuclear explosion at high altitude carried out by USA above Johnston island in Pacific Ocean on the 8th of July 1962, high intensity radiation zones, with appearance of which the radiation environment in space has considerably deteriorated. Continuous observations of the physical state of the outer space, in particular of the radiation level, conducted by the Soviet satellites of the "Kosmos" type, made it possible to fix, that as a result of this nuclear explosion an artificial radiation belt has been formed, getting into which would have been extremely dangerous for the health of the spaceman. But at the moment of launching

"Vostok-3" and "Vostok-4" the intensity of radiation, caused by the American nuclear explosion at high altitude, has decreased at the altitude of the spaceships flight to tolerable limits.

For a quick control of radiation environment in space a special dosimeter was carried aboard the spaceships "Vostok-3" and "Vostok-4", the reading of which was automatically transmitted through radio-telemetric system to ground stations.

The composition of dosimeter included a pickup, which was a gas-discharging counter of nuclear radiation, and electronic memory circuit. The latter could accumulate information from a doze of 1 rad upto a doze of 100 rads. It should be mentioned, that this dosimeter was of high reliability and operated without fail throughout the flight of "Vostok-3" and "Vostok-4". Moreover, the spacemen were provided with various types of individual dosimeters. A part of these was meant for additional measuring of the total doze, received by the spaceman, the other part - for estimating the nature of the radiation.

For the appraisal of radiation danger special biological investigations were to be conducted, for which various biological objects on microbiological, cytological and subcellular level were being carried by "Vostok-3" and "Vostok-4".

The sending of biological objects made it possible, on one hand, to check additionally the biological effect of cosmic radiation and other flight factors, and on the other - to conduct special radio-biological experiments.

As pointed out above, primary cosmic radiation gives very insignificant doze, recordable by physical instruments. However from the reading only of physical instruments we cannot speak of the possible biological effect of the given radiation doze. Therefore there was the need to estimate the relative biological effectivity of the primary cosmic radiation. Moreover the physical devices absolutely do not take into account the background, against which the cosmic radiation is acting. In space flight the organism is affected by a whole series of physical factors, the majority of which are very seldom or not at all encountered on the Earth: overstrain, vibrations, weightlessness, etc. The estimate of their effect could only be made by means of biological tests. The most convenient in this respect are the unicellular or the simplest organisms, on which it seems possible to follow the biological effect of individual heavy charged particles and to estimate the hereditary changes.

As we know, the highest and lowest plants, micro-organisms and other species of animal and plant world will be constantly accompanying the spacemen in their prolonged space flights as components of the future ecological system of the spaceship. The possibility is not excluded, that under the effect of cosmic radiation and other factors of space flight there may emerge genetic and cytological changes, which may result in disturbing the biological association in the ecological system of the spaceship. This is why even now the investigations should be conducted in the pointed out direction for the development of a stable ecological systems.

The spaceships "Vostok-3" and "Vostok-4 carried aboard the following biological objects: lysogenic bacteria, culture of the human cancer cells, Drosophylla flies and fertilized spawn of loach; Nigella bulbs, seeds of wheat, pine, pea, mustard, cabbage, beetroot, carrot, raceme of trandescantia.

At present all the bilogical objects are at the investigation stage, but even now it can be said, that cosmic radiation had no adverse effect on them whatsoever.

In order to enhance the radiation safety spaceships "Vostok-3" and "Vostok-4" had the necessary constructive protection, preventing penetration into space cabin of a certain part of cosmic radiation, and also protecting this cabin to a considerable extent from the effect of radiation, connected with the nuclear explosion in space.

Moreover, in the case of a sharp deterioration in the radiation environment to prevent the injuring effect of radiation the spacemen were provided with special radio-protective preparations.

In the case of need with dangerous for the spacemen's health rise in the level of cosmic radiation (due to any of the above mentioned reasons (for instance, after an unforeseen considerable solar flare) from the reading of a radiometer on board) the decision could be taken for the urgent landing of the spaceship.

Processing of the obtained information has shown, that the doze, received by both the spacemen during one day of flight, composed about 11 milliard. The total doze, received by A.G. Nikolaev was 43 milliard, and by spaceman P.R. Popovich - 32 milliard. These dozes are absolutely harmless for the health of a man.

VI. Medico-biological questions.

1. Preparation of spacemen.

Preparation for the flight was preceded by a special selection of the spacemen out of the whole group with an estimate of the forthcoming flight's duration of three days. In the selection the consideration was made primarily of the personal qualities of the spacemen, their knowledge, readiness to accomplish the composite space flight. Besides the generally known methods of examination, which permit to selected physically and psychologically sound people, the application was made also of specially developed methods in order to :

a) define the reserve possibilities of a man with effect of certain factors, inherent to spaceflight;

b) determine peculiarities of the physiological effect of analyzers, which play a significant role in forming the man's space ideas. These analyzers include vestibular, visual, motor, cutaneous, etc.

The understanding of a man's health does not expose his properties, characterising endurability against the effect of external medium factors, possibility of adaptation to these and suppression by means of various internal mechanisms the unfavorable reactions.

For instance, certain so called vestibular tests, adopted to determine the fitness for the flying service, are found to be insufficient to determine the capacity of a man to endure prolonged rotation, overstrains or various combinations of vestibular irritations. At the same time a man may suppress to a certain extent the organic reactions, emerging with vestibular irritations, by will power, with the help of muscular strain or visual stimulation. Hence there is a necessity to investigate the regularities of the reciprocal effect of the sense organs on each other, so as to determine the conditions, which either disinhibit, or suppress reactions of each analyzer individually. The defined regularities help to recommend ways for inhibition of adverse reactions in flight.

On the whole the investigation methods make it possible to divide all men into groups from the viewpoint of their individual characteristics, determining the nature of reactions in response to most diverse external effects, no matter how they varied. The selection for space flights is of persons, the most stable in all the indices, capable of enduring prolonged irritations and relatively quickly becoming adjusted to them.

An important stage in the general system of picking spacemen was the psychological study of each of them, meant for defining emotionally stable persons, of quick general reaction, good memory, attention, capable within a short time to develop purposeful coordinated movements.

At the same time it should be mentioned, that individual characteristics of a man are not stable: firstly, there are any departures from the generally recognized conventional standards; secondly, the stability of organism against the external effects could be enhanced within very wide limits. This is attained by a corresponding preparation. This preparation is one of the main tasks of the space medicine, the role of which is confined to developing measures, tending to enhance the stability of a man against the factors of space flight.

The program of the special training and preparation of spacemen was composed on basis of the modern concepts regarding space factors, which could be divided into several groups. The of these is unified by the concept of space conditions, as a unique medium of habitation. In this case the spaceship is a reliable shelter, protecting from harmful phenomena. These could be the total vacuum, ultraviolet, infrared and the visible part of the solar radiation; ionizing radiation; unusual for the sight organs contrasts of light and shadow.

Another group of factors is connected with dynamics of the flight - noises, vibrations, overstrains (during the orbital insertion and re-entry), weightlessness, prolonged effect of vestibular irritation in the shape of rotations and oscillatory motions of the spaceship.

Finally, factors should be taken into account, connected with conditions of the spaceman in the space cabin; peculiarities of microclimate, thermal conditions, isolation of the space man in confied conditions of the cabin with restricted mobility; unique food, special working conditions and unusual clothing; psycho-nervous tension, specified by the novelty, unusualness of environment, different in comparison to Earth spatial and time relations; necessity to take responsible decisions in composite conditions of space flight.

The modern medical science and its young branch - space medicine - does not as yet have at its disposal the ready recommendations for all the conditions, in which the spaceman may find himself. If the flight of Yu. A. Gagarin enabled to obtain only some data in this direction, the flight of G.S. Titov, which continued for 25 hours, have forced to supplement and improve to a considerable extent the system of preparation.

Proceeding from the theoretical reasoning, that prolonged weightlessness may, apparently, change to some extent the fixed systematism in the interaction of analyzers, which is present in conditions with the active gravity field of the Earth, the preparation program provided for enhancing the vestibular stability of each spaceman for the flight.

The preparation of spacemen Nikolaev and Popovich provided for their acquiring definite theoretical knowledge, and also implementation of special training programs in order to enhance the stability of organism against the effects of the space flight factors and for mastering required practice in controlling various composite systems and mechanisms of the spaceship.

The special training included flights on planes, adapted for creating weightlessness for a brief period; prolonged staying in pressure chambers; tests in heat chambers with build up of heat strain; rotation on centrifuge; tests on vibrating stands; parachute training; general physical training.

All types of training was supplemented by general physical preparation, which was directed, in particular, to perfecting the skills, required for the space flights (movement coordination, ability to control one's body in space, etc.). On the whole the training, associated in a number of cases with considerable emotional tension, strengthened the will power and psycho/nervous sphere of the spacemen.

During working corrections were introduced into training in relation to individual characteristics of the spacemen, capacity to endure one or another strain. A lot of attention was paid to the sequence of individual types of training.

2. Microclimate in the cabin.

The human organism is capable of maintaining normal vital activity during a long time only in certain conditions of the ambient microclimate. For instance, partial pressure of oxygen in the air should not be below 160 mm of mercury, limit content of carbon dioxide is tolerated within limits not exceeding 1-2%.

If the changes in microclimate are considerable, these departures from the normal may exhaust the reserves of a man. Then the "equilibrium" of organism with surrounding medium is disturbed, which results in deviations in the state of physiological systems. In application to space flight any, even the minimal changes in microclimate mean additional physiological strain on the organism, which to a considerable extent diminishes the capacity of a man to endure such effects, as overstrain, weightlessness, prolonged isolation, vestibular irritations, etc.

The accomplishment of space flights in the Soviet Union was preceded by a lot of scientific research on fixing parameters of the microclimate in the space cabin, creating methods and means for their maintenance and checking during the whole period of the flight.

The flights of Yu. A. Gagarin and H.S. Titov confirmed the correctness of data, obtained in scientific research, and construction decisions in this respect. At the same time the material, collected as a result of the flights, made it possible to develop more firmly based technical and physiologo-hygienic requirements of hermetic cabin in the new spaceships, estimated for prolonged staying of a man in space.

Air-regeneration system was used for maintaining normal gas composition of the cabin. This is an air-conditioning system with double control - automatic and manual. It provides emanation of oxygen in a quantity required for breathing, absorbtion of carbon dioxide and moisture, exhaled by a man, elimination of various harmful admixtures in the air and vital activity products of a man. A man during one hour exhales about 25 litres of carbon dioxide and 60 g of moisture and consumes upto 30 litres of oxygen. Special filters were developed to neutralize the harmful admistures in the air.

Deviation from the present content of oxygen, carbon dioxide and water vapour in the cabin's air were registered by special sensors, signals from which were directed to automatic regulator controlling the process of chemical reactions within the regenerator.

Moreover, the spaceman himself could adjust within certain limits the requirement of oxygen, separated by the system, and to fix the desired gas composition in the cabin, humidity and temperature. Changes of parameters in life support conditions of the cabin the spacemen observed from instruments and regularly transmitted them to the Earth. Verbal transmissions were duplicated by telemetry.

3. The meals of spacemen in flight.

The food of A.G. Nikolaev and P.R. Popovich consisted of natural products taking into account their individual taste. The food included various sandwiches, meat products, pies, fruits, all packaged, as well as full-value food products and prepared dishes in liquid and puree form, hermetically sealed in aluminum tubes. The ration products were prepared with rigid observance of all the hygienic requirements, and their special treatment increased the period of their storing, without loosing their taste.

The daily ration, estimated for four meals, was saturated with vitamins and consisted of first and second breakfast, lunch and dinner. Intervals between the meals was 4-5 hours. The approximate energy value of each meal was the following: first breakfast - 730-740 calories, second breakfast - 720-730 calories, lunch - 770-780 calories, dinner - 470-480 calories. Total 2690-2730 calories.

A special reservoir of polyethylene was constructed to provide the spaceman with water, which made it possible to drink water without any trouble in conditions of weightlessness. The preservatives, added to water, made it pleasant tasting throughout the flight.

During the flight the spacemen used a special sanitary arrangement, condition of weightlessness did not hamper it.

4. Medico-biological investigation methods.

One of the important problems of the many-day group space flight was to obtain additional data on the space flight effect on human organism, in particular on the state of the central nervous system and vestibular apparatus. Resolution of this problem required considerable expansion of biological investigations program on spaceships "Vostok-[illegible]" and "Vostok-[illegible]" in comparison with flights of Yu. A. Gagarin and G.S. Titov. With this object new methods were devised for investigations and the necessary medical instruments were set up on board the spaceships. The basic methods for obtaining medico-biological data were:

- recording and transmission of a considerable volume of objective data on the state of spacemen by radio-telemetry;

- television observation of the spacemen, which made it possible to get an idea about behavior, motor activity, coordination of movements and attitude in flight;

- checking of the spacemen's radio-conversations with Earth, on basis of which it was possible to draw conclusions as to the efficiency and the feeling of spacemen;

- evaluation of the volume and quality in the implementation of the flight assignment as a whole and its individual details.

The telemetric systems of spaceships "Vostok-3" and "Vostok-4" have well served the recording of physiological indices: electrocardiograms, pneumograms, electro-oculograms, electroencephalograms, galvanic skin reactions, pulse and respiration rate, etc.

Electrocardiography - method for investigating electric activity of myocardium, characterizing its automatism, irritability, conductivity and partially the contractile function. Electrocardiography provides checking of the cardio-vascular system and was repeatedly used in the previous space flights, which enabled to compare the obtained data.

Pneumography - method for recording respiratory movements. The rate of respiration and its nature are important physiological indices of the human organism state.

Electroencephalography - method for investigating biocurrents of cerebrum. Electroencephalogram reflects the total physiological state of the central nervous system and enables to judge its reactions to various effects, connected with the many-days space flights. Introduction into program of electroencephalography aimed at investigating the psycho-nervous state of the spacemen with prolonged weightlessness. Electroencephalography permits to some extent to check also the state of sleep, being awake, fatigue and excitation.

Investigation of galvanic skin reactions also serves to study the state of the central nervous system. The galvanic skin reactions are a composite set of the bioelectric skin activity, specified by biocurrents of sweat glands and its ohmic resistivity. Changes in the resistivity of skin are connected with nonspecific reactions of organism as a result of excitation of the highest organic centres and came on with various constant, for instance painful irritations, emotional tension, etc.

Electro-oculography - method for recording movements of eyes, based on picking at this moment differences of potentials between the positively charged eyeball and its negatively charged retina. In these cases the eye is as though an electric condenser. Moreover, special arrangement of the electrodes enabled in some cases to record also the biocurrents of eye muscles. Application of this method was caused by the need to obtain objective information on the appearance of vestibular disorders.

As we know, one of the irritation symptoms of vestibular apparatus is the nystagmus - involuntary rhythmic movements of the eyeball, characterized by a certain swing and quickness. Besides, the electro-oculogram provides some idea as to the motory activity of the spaceman.

The flight assignment envisaged implementation by a spaceman of a number of special tests required for appraisal of the mental capacity and physical state of the spaceman. Of special interest are psychological tests. These permit to define fatigue or excitation of the spaceman, to get an idea of his efficiency.

The tests were conducted in the following way. The spaceman loudly named geometrical figures, drawn on a chart of the log book. The order of reading was determined by the special instruction. In one case the figures were read vertically, in another - horizontally, in the third - over one or two figures. In the same way were conducted verbal arithmetic actions with a number of successive columns of figures. In one or another test the indices of efficiency were the time, consumed for the test and the number of allowed errors.

The spaceman's voice during these tests was recorded on the ship's tape-recorder, so that the test during the flight could be compared with the data, obtained in the laboratory. The spacemen also conducted test for time, which consisted in reading 20-second intervals with fixing of obtained result from the stop-watch.

The appraisal of the state and efficiency of the spacemen could be accomplished from implementation of other details in the space assignment. For instance, from the quality of implemented scientific observations, with which they were entrusted, from the entries in log book, etc.

Thus, the program of medico-biological investigations in the flight of Nikolaev and Popovich was carefully worked out and was of purposeful nature. During the preparations this program was studied by the spacemen, who during the flight were themselves investigators, having thereby considerably helped doctors and biologists.

5. Results of physiological investigations in flight.

During the pre-takeoff period the state and the feeling of the spacemen were excellent. In the morning at the day of takeoff the last recordings were made of physiological functions. 4 hours prior to takeoff pulse rate of Nikolaev was 72, respiration rate - 11. Popovich had respectively 80 and 15. Hence due to pre-takeoff emotional tension there was a gradual quickening of the pulse in both the spacemen, just as it was in Gagarin and Titov. Thus, 1 hour prior to takeoff the pulse rate of Nikolaev was upto 88, of Popovich 100; 5 minutes before takeoff it reached in Nikolaev 115, in Popovich 110.

The orbital insertion both the spacemen stood well. In propulsion branch pulse rate of Nikolaev was upto 120, of Popovich - 130. In conditions of weightlessness the spacemen felt well. The pulse rate of Nikolaev came down to initial normal values after 10-12 hours, of Popovich - after 6 hours.

Throughout the flight pulse rate of both the spacemen varied within 50-80. No disorders were defined in electro-encephalograms and recording of galvanic skin reactions of either of the spacemen.

During the flight the state and well-being of the spacemen remained good. Excellent implementation of the flight assignment indicates high level of the spacemen's efficiency. A. Nikolaev and P. Popovich implemented all the assignments strictly in accordance with the flight program. As we know, the spacemen realized themselves from the harness and "free floated" in the cabin, the coordination of movements and orientation were not distrubed in this case.

During the whole flight the spaceship's systems performed well. The hygienic parameters of the cabin were maintained at prescribed level. Prior to descent a slight quickening was noted in the spacemen of the pulse and respiration. The descent they stood well. The landing was successful. No injuries or bruises were received. One hour after landing the pulse rate of Nikolaev was 96-104, of Popovich 85 with respiration rate 14 and 16 respectively. The post-flight examination did not reveal any disorders.

As a result of the many-days flight of Nikolaev and Popovich and enormous volume was obtained of radio-telemetric information.

As a result of intensive study of radiotelemetric recordings and all material of the flight new scientific data were obtained, required for even longer space flights.

At present it is possible to draw the following medico-biological conclusion.

The general conditions and the main physiological functions of the spacemen remained normal throughout the flight.

Thus, it has been fixed, that in conditions of space flight lasting for about 100 hours the physically healthy man, who passed the necessary preparation, is quite capable of enduring weightlessness. Weightlessness with fixed conditions does not cause any changes in the daily periodicity of physiological processes in the spaceman's organism.

An important factor, confirmed in practice, is that the efficiency of the spacemen at every branch of the flight was always retained at required level and invariably assured implementation of assignments, envisaged by the flight program. The possibility was repeatedly checked and confirmed of carrying out the necessary working operations in conditions of sufficiently prolonged unfixed attitude and free floating of spacemen in the cabin with weightlessness.

Considering the above stated facts, it may be assumed, that flights lasting for several hundred hours will also be attainable for spacemen with the necessary preparation.

Methods, adopted for the preparation of spacemen, were quite justified, although investigations in this direction and development of new methods should continue, taking into account the high reserve possibilities of a man in the sense of stability development against the effect of the highest factors.

The systems of life support and of individual equipment assured maintenance in the cabins optimum conditions for the life and work of the spacemen.

The obtained extensive and many-sided practical data enable to conduct even more purposefully the experimental medico-biological investigations in future space flights.

VII. Implementation of the group flight.

The carrier-rocket with spaceship "Vostok-3", manned by A.G. Nikolaev, tookoff at 11 hours 30 minutes Moscow time on the 11th of August 1962.

The carrier-rocket with spaceship "Vostok-4", manned by P.R. Popovich, tookoff at 11 hours 02 minutes on the 12th of August 1962.

The takeoff of both the carrier-rockets, as mentioned, was from one of the launching pads of the cosmodrome. Both the spaceships were inserted into orbits, close to calculated one, at prescribed time. From confirmed data the initial orbital parameters of "Vostok-3" were the following: orbital period 88.33 min. altitude at apogee 234.6 km, altitude at perigee - 180.7 km.

The initial orbital parameters of "Vostok-4" during the first day of the flight were as follows: orbital period - 88.39 min, altitude at apogee - 237.7 km, altitude at perigee - 179.8 km.

Although the atmospheric density at the altitude of the flight is very low, it was still sufficient to affect appreciably the orbital parameters of spaceships in prolonged flight. Given in the table are data on the orbital parameters changes of spaceships.

		11.VIII 1st Revolution	12.VIII 17th Revolution	13.VIII 33rd Revolution	14.VIII 49th Revolution	15.VIII 64th Revolution
Orbital period (min.)	"Vostok-3"	88,330	88,260	88,180	88,084	87,972
	"Vostok-4"	-	88,390	88,310	88,224	88,133
Altitude at apogee (k)	"Vostok-3"	234,6	229,9	224,4	217,7	210,3
	"Vostok-4"	-	236,7	231,7	226,1	220,4
Altitude at perigee (km)	"Vostok-3"	180,7	178,0	175,2	172,0	168,1
	"Vostok-4"	-	179,8	177,4	174,4	171,4

The takeoff time and the tuning of control instruments of "Vostok-4" were taken in a way, that after its insertion the distance between spaceships would be about 5 km.

Processing of results from the orbital parameters measuring of both the spaceships has shown, that the minimum distance between them after the insertion of "Vostok-4" was 6.5 km. This high accuracy in the orbital insertion of the second spaceship indicates high perfection of the Soviet carrier-rockets and all the launching systems.

Thereafter, due to different orbital parameters the distance between "Vostok-3" and "Vostok-4" increased and composed:

- in the morning on the 13th of August at the 33rd revolution of "Vostok-3" 850 km;

- in the morning of 14th of August at the start of the 49th revolution of "Vostok-3" 940 km.

- in the morning of the 15th of August at the start of the 64th revolution of "Vostok-3" 2850 km.

During the whole flight instruments of both the spaceships operated normally. The airtightness of all compartments was fully retained throughout the flight. Pressure in both the space cabins was within 755-775 mm of mercury. The thermal control systems maintained the prescribed temperature conditions. Temperature in "Vostok-3" cabin varied within 1[illegible]-26°C in "Vostok-4" cabin - 12-28°C (the higher temperature pertains to pre-takeooff period). Oxygen content in the atmosphere of the cabins varied from 21 to 25%, of carbon dioxide not above 0.5%. Both the spacemen during flight carried out the program assignment, maintained steady contact with each other and with ground stations in accordance with the flight program.

Some observations, made by the spacemen during the flight, are most interesting. Of special interest is the experiment of leaving the seat and "free floating" in the cabin for quite considerable time. Spaceman Nikolaev was outside the harness during the four sessions for about 3.5 hours, and spaceman Popovich during three sessions - for about 3 hours. Floating around the cabin the carried on observations, checked their capacity to get oriented in the cabin, conducted communication (through microphones and loud-speakers in the cabin). Throughout this time both felt fit, did not experience any unpleasant sensations, specially no disorders. This is a very important result, obtained in the group flight.

The obtained results permit to hope, that in future prolonged flights the man will be able to work normally, without being fixed in the seat, for quite a long time.

The spacemen conducted a number of observations inside the cabin. An interesting experiment was conducted by P.R. Popovich. He observed air bubbles in hermetic flask, filled about three-quarters with water. In calm state the whole air collected into one big bubble in the middle of the flask, whereas the water was gathered on the edges. After shaking the big bubble broke into many small ones, which, however, again gradually gathered into one big bubble P.R. Popovich also tried to spray the water around the cabin - the water in the form of small balls moved to the periphery of the cabin and settled on its walls.

The spacemen conducted observations through the portholes. They could distinguish shore line, rivers, mountains and cities, observed "sunsets" and "sunrises"; flying above Northern America they observed thunderstorms. They found it interesting to observe earth surface, when the spaceship was in its shadow. There was a full moon during the flight and the earth surface appeared as a grey shroud, against the background of which the spacemen saw liten up towns.

By morning of the 15th of August the program was fully completed. According to program the spaceships should have landed in Kazakhstan at 48°N. It was proposed to use for landing automatic systems, providing for descent from the orbit and landing.

At 9 hours 24 minutes Moscow time the brake motor of the spaceship "Vostok-3" was switched and after 6 minutes of the spaceship "Vostok-4", and thereafter the spaceships began to descend. At low altitude, when the spaceships have passed the region of high temperatures and overstrain, the spacemen separated from the ships in ejection seats and opened out parachutes. The spaceships continued their descent and safely landed by means of the automatic systems. Both the spaceships on landin, were found to be in good condition and can be used for repeated flights. According to verified data A.G. Nikolaev landed at 9 hours 52 minutes and P.R. Popovich - at 9 hours 59 minutes. Both the spacemen landed close to their spaceships.

A.G. Nikolaev landed at a point with coordinates 48°02' N and 75°45' E.

P.R. Popovich landed at a point with coordinates 48°10' N and 71°51' E. Difference in the longitude of landing is determined by the relative course shifting of the spaceships flight due to different time of the flight and some difference in the orbital parameters. At the place of landing the spacemen were met by the technical maintenace personnel, search and rescue service, doctors, correspondents and sport commissars.

The flight of A.G. Nikolaev lasted 94 hours 22 minutes. During this time he completed over 64 revolutions around the Earth and covered a distance of about two million six hundred thousand km. The flight of P.R. Popovich lasted 70 hours 57 minutes. He completed over 48 revolutions around the Earth and covered a distance of about one million nine hundred eighty thousand km.

VIII. Main results of flights.

1. The program of group flight of the Soviet spaceships "Vostok-3" and "Vostok-4", which were named by pilot-cosmonauts of USSR comrades A.G. Nikolaev and P.R. Popovich, was fully and successfully completed.

2. As a result of the flight an extensive experimental material was obtained, including tape recordings, photo and cine-films, entries in log books and in journals at ground stations, radio-recordings, etc.

3. The powerful carrier-rockets reliably assured insertion into exactly calculated orbit of spaceship "Vostok-3" and a day later insertion with high precision of spaceship "Vostok-4" which enabled to attain the least distance between the ships of about 6.5 km.

In the takeoff of both the spaceships the carrier-rockets were launched with deviation of less than one second from the calculated time. The control service of the spaceships orbits and Coordination centre provided high accuracy and quickness of data analysis and forecasting.

4. The equipment of both the spaceships throughout the flight operated reliably and without fail. During the orbital insertion, in flight and at landing the parameters and characteristics of all the systems, units, instruments of spaceships were within the fixed norms. Interesting data were obtained with the joint flight of both the spaceships and with their practically simultaneous landing in prescribed area.

The accumulated positive experience of ensuring very high reliability and faultlessness of the whole equipment complex - carrier-rockets, spaceships and ground measuring and control service and communication in the implementation of the composite many-days group flight is a valuable basis for further development and perfecting of the rocket and space technique.

5. One of the most important results of the flight are data, obtained with prolonged stay of spacemen in condition of weightlessness.

Both the spacemen felt quite fit with prolonged weightlessness. They fully retained their efficiency and after many-days flight tolerated quite normally the overstrains, which are active on descent trajectory and at landin . With the free floating in the space cabin the efficiency of the spacemen was not reduced, thier well-bein did not deteriorate. Therby it has practically been proved, that a man, physically healthy, who has passed an appropriate preparation, can retain with prolonged weightlessness his efficiency and normal vital activity.

It may be expected, that in future even longer and distant flights will be possible for people.

6. During the flight the spacemen had good communication with the ground centres and with each other. For the first time TV transmission on a large scale was accomplished from aboard the spaceships and its retranslation into many countries.

7. The composite ground measuring complex, service of communication and flight control and all the technical services connected with the flight worked faultlessly.

The successful accomplishment of the long group flight in space of the Soviet spacemen A.G. Nikolaev and P.R. Popovich on spaceships "Vostok-3" and "Vostok-4" - is a new important step in the man's conquest of space.

"Pravda", 2. October 1962.

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- continued study of the effect of various space flight factors on human organism;

- implementation of extensive medico-biological investigations in conditions of prolonged flight;

- further working and improvement of systems in a manned spaceship.

The spaceship satellite "Vostok-5" was placed into orbit close to calculated one. According to preliminary data orbital period of the spaceship is 88.4 min, distance at perigee and at apogee is 181 and 235 km respectively, orbital inclination about 65°. A two-way radio-communication is continuously maintained with "Vostok-5".

According to communication of comrade Bykovskii and data of telemetric and television systems, he satisfactorily stood the period of orbital insertion and transition to weightlessness, Comrade Bykovskii is feeling quite fit.

The spaceman's transmissions are on frequencies 20.006 and 143.625 Mcps. All systems aboard the spaceship operate normally.

Communications on the flight's progress will be transmitted by all the radio stations of the Soviet Union.

"Pravda", 14 June, 1963 (Special edition).

STATEMENT OF SPACEMAN V.F. BYKOVSKII BEFORE TAKEOFF.

Dear comrades, friends! The successful mastering of space, begun by the Soviet people, is a result of creative daring of our heroic nation and putting into practice historic plans of the Communist Party.

Less than one year has passed since my friends - spacemen Andriyan Nikolaev and Pavel Popovich following Yurii Gagarin and Herman Titov have accomplished a group space flight. Today I share the great honour - to continue the cause, initiated by our Soviet Motherland.

I assure the Lenin's Central Committee of the Communist Party of Soviet Union, our Soviet Government, dear countrymen, that I shall apply all my efforts, knowledge and skill, to implement honorably the responsible and noble assignment.

Untill we met again on our dear Earth!

"Pravda", 14 June 1963 (Extra issue).

Pages from biography.

Valerii Fedorovich Bykovskii was born in 1934 in the town of Pavlovskii Posad of Moscow region.

From the age of seventeen years he joined aviation. While still in the Middle School he finished the Moscow aeroclub.

Thereafter he studied in the air-force school of initial pilot training. After finishing this school he served in 1955 as pilot with various section of airforce.

The commanding officer speaks well of Valerii Bykovskii, mentions that he flies bravely, sensibly, calm in flight, quick to take decision in an emergency. The special training he completed successfully. Knows very well the equipment. Working as instructor he skilfully transmits his knowledge and experience to comrades. He has completed 72 jumps with parachute.

For his service in the Soviet Army V.F. Bykovskii was awarded the order of Red Star and medals "40 years of Armed Forces of USSR" and "For faultless service". In 1959 the title "Fighter-pilots second class" was conferred on him, and later on the title "Air-borne force instructor".

Lt. Col. V. Bykovskii is studying in Zhukovskii Air-Force Engineers Academy. He has a wife, Valentina Michailovna Bykovskaya, who is working as laboratory assistant. They have a son a few months old.

The father of the spaceman Fedor Fedorovich Bykovskii is a pensioner. Mother - Klavdia Ivanovna is a housewife. His sister Margarita Fedorovna is working as economist-inspector in a bank.

"Pravda", 14 June 1963 (Special edition).

TASS COMMUNIQUE "VOSTOK-5" IN FLIGHT.

Spaceship "Vostok-5", manned by pilot-cosmonaut comrade Bykovskii continues its flight. At 18 hours Moscow time the spaceship satellite "Vostok-5" completed two revolutions around the Earth. Pilot cosmonaut Bykovskii is feeling excellent. All the systems of the spaceship operate very well. The prescribed conditions are being maintained in the space cabin.

After implementation of physiological tests prescribed by the program and checking the state of his own organism, the spaceman had his meal.

At the end of the first revolution the Spaceman-Five V.F. Bykovskii, while flying above Africa, warmly greeted the multimillion freedom-loving African people.

Flying above the Soviet Union the Spacemen-Five transmitted the following radiogram:

"Ardent greeting to heroic Soviet people - builder of communism, pioneer in space conquest".

When the spaceship satellite "Vostok-5", having completed one revolution, was again above the territory of our Motherland, Comrade Bykovskii transmitted greeting to the people of the Soviet Union and reported to the Central Committee of the Communist Party of Soviet Union and the Soviet Government about the successful flight of spaceship "Vostok-5".

At 22 hours Moscow time the spaceship "Vostok-5" completed the fifth revolution. According to confirmed data, orbital period of the spaceship is 88.27 minutes, distance at perigee 175 km, distance at apogee 222 km, orbital inclination $64^{\circ}58'$.

Flying above Europe V.F. Bykovskii transmitted the following radiogram:

"Hearty greetings to the people of Europe, wish you peace and happiness".

The next radiogram of V.F. Bykovskii runs as follows:

"Flying above the territory of China I send brotherly greeting from aboard the Soviet spaceship "Vostok-5" to the great Chinese people".

Being above the American continent, the Soviet spaceman transmitted from aboard the spaceship "Vostok-5":

"From the bottom of my heart I greet the people of Latin America, wishing them peace and well being".

"Hearty greeting to heroic people of revolutionary Cuba".

When "Vostok-5" was flying above the Australian continent the fifth Soviet spaceman greeted the people of Australia.

During the flight he carried out the physiological and vestibular tests prescribed by the program; as well as a series of physical exercises. Spaceman Bykovskii ate with appetite roast-beef and boned chicken. He feels fit and can well tolerate weightlessness. His pulse rate is 76, respiration rate 24.

On the fourth revolution Bykovskii had a friendly conversation with Spaceman-Four Pavel Popovich, who transmitted hearty greetings to him, family and friends.

Completing the research program of the first day spaceman Bykovskii will sleep after 24 hours Moscow time.

"Pravda", 15 June 1963.

TASS COMMUNIQUE "VOSTOK-5" CONTINUES ITS FLIGHT.

On the 15th of June 1963 at 8 hours 30 minutes Moscow time spaceship "Vostok-5" completed 12 revolutions around the Earth.

At the end of the seventh revolution the spaceman comrade Bykovskii has completed the work, prescribed by the program. Before going to sleep at 00 hours 05 minutes the spaceman informed, that all the systems of the spaceship operate normally, temperature in the cabin; 20°C, humidity 57%, he is feeling fine.

According to telemetric data the pulse rate of spaceman is 64, respiration 20. The sleep of comrade Bykovskii was deep and restful. Pulse rate during sleep was 4[illegible]-56. At 7 hours 00 minutes the spaceman woke up, informed about feeling well, completed a set of physical exercises breakfasted and began implementation of further program.

On the 15th of June at 15 hours Moscow time the spaceship "Vostok-5", manned by the pilot cosmonaut Bykovskii, completed the first 24 hours of its flight. During this time the spaceship satellite more than 16 times orbited the Globe, having covered 670 thousand km.

At 15 hours orbital parameters of the spaceship satellite were the following: distance at perigee 173 km, at apogee - 219 km, orbital period - 88.2 minutes.

Throughout the flight the spaceman felt well. He is cheerful and successfully carries out the flight and scientific research program. The first flight day program included physiological, in particular vestibular, tests, checking the state of his own organism, maintenance of communication on short and ultrashort waves channels, observation of earth surface, Sun and Moon.

At one of the revolutions the spaceman took over the control to check the working of the manual orientation style.

Flying above the North American territory the spaceman transmitted greeting to the people of USA.

The spaceman took his meals at set hours. The diverse menu of the spaceman included roasted tongue, sausage pies, cutlets, oranges, prune puree, black and white bread and other high-calory food stuffs.

The spaceman informs, that his appetite is good. The six-hour sleep was restful and strengthened the spaceman. At seven in the morning the spaceman wokeup and began implementation of the second day's program.

The conditions in the space cabin continue to remain normal: pressure - 775-780 mm of the mercury, humidity - 40-65%, the set temperature in the cabin is maintained automatically but the spaceman can, if he wishes, to adjust the temperature within 12-20°C.

All devices and systems of spaceship "Vostok-5" operate normally. Telemetric information is regularly incoming from aboard and permits to estimate the performence of all the equipment of the spaceship and to obtain objective data on the state of the spaceman's organism.

According to telemetric data, pulse rate of the spaceman - 65-70, of respiration - 17-20.

The flight of Spaceman-Five continues.

The second day of the Spaceman-Five flight is coming to an end. At 22 hours Moscow time the spaceship satellite "Vostok-5" has completed over 20 revolutions around the Earth. The spaceship is now in flight over 30 hours. The spaceman had a strenuous working day, filled in with various investigations according to the flight program. On the 15th revolution the spaceman came out from the harness and free floated in the cabin. This was visible on the screens of television. At 18 hours the spaceman lunched. After lunch he again conducted various observations and investigations, prescribed by the flight program, carried out physiological tests and physical exercises.

The flight program included also observations of the earth surface and of horizon. From an altitude of over 200 km Bykovskii easily distinguished outlines of continents, rivers, mountains and cities.

The communication with spaceman on ultrashort and short wave channels is quite stable. The radar stations continue to measure orbital parameters of the spaceship-satellite and automatically transmit data to electronic computers. All the equipments of the spaceship operated reliably.

Flying above the territory of our Motherland, the spaceman transmitted greetings to the glorious Lenin's comsomol, to the whole Soviet youth. When the spaceship was above Asia, the spaceman transmitted greetings to the Near and Middle East nations. On board the spaceship telegrams were transmitted from the parents and relatives of the spaceman, his brother officer, I.N. Kozhedub, thrice Hero of the Soviet Union.

The spaceman feels well and his mood is cheerful. The pulse rate as before is 60-65, respiration - 17-20. The conditions in the cabin of "Vostok-5" are maintained normal.

"Pravda", 16 June 1963.

TASS COMMUNIQUE ON THE LAUNCHING OF SPACESHIP SATELLITE "VOSTOK-6".

On the 16th of June 1963 at 12 hours 30 minutes Moscow time spaceship "Vostok-6" was placed into earth orbit in the Soviet Union. The spaceship is piloted by the first in the world woman - citizen of the Soviet Union comrade Tereshkova Valentina Vladimirovna.

In this flight the study will be continued of the effect of the various spaceflight factors on the human organism, including the comparative analysis, which will be conducted during this flight, of the effect of these factors on the organisms of man and woman, new medico-biological investigations will be carried out and the working and improvement of the manned spaceships systems in conditions of joint flight.

In accordance with the set program the launching of the spaceship "Vostok-6" was implemented during the orbiting of the spaceship "Vostok-5", launched in the Soviet Union on the 14th of June 1963.

Now there are two Soviet spaceships simultaneously orbiting the Earth "Vostok-5" and "Vostok-6", piloted by the citizens of the Soviet Union comrades Bykovskii Valerii Federovich and Tereshkova Valentina Vladimirovna.

The transmissions of Tereshkova are on frequencies 20,006 and 143.625 Mcps. The spaceship also carries transmitter "Signal", operating on frequency 19.995 Mcps.

A two-way communication has been established between the spaceships "Vostok-5" and "Vostok-6".

All systems aboard the spaceships "Vostok-5" and "Vostok-6" operate normally.

Communications of the progress of the joint flight will be transmitted by all radio-stations of the Soviet Union.

"Pravda", 16 June 1963.

STATEMENT OF THE FIRST IN THE WORLD WOMAN COSMONAUT VALENTINA TERESHKOVA BEFORE TAKEOFF.

Dear comrades, friends, countrymen!

I thank from the bottom of my heart Lenin's Central Committee of the Communist Party of the Soviet Union, Soviet Government, the whole Soviet people for the honor of entrusting me with the accomplishment of a space flight.

I'am proud, that our talented Soviet people became a pioneer in the mastering of space and by its successes caused general admiration of mankind.

I'am happy, that I, first in the world woman - citizen of the Soviet Union - will accomplish a space flight.

I assure our heroic Party, Soviet Government, that the assignment entrusted to me I shall accomplish with credit.

Till we meet again soon on our dear happy land of Soviets!

"Pravda", 16 June 1963 (Special edition).

<u>The first in the world woman-cosmonaut, pages from biography.</u>

Valentina Vladimirovna Tereshkova - first in the world woman-cosmonaut - was born in 1937 in Maslennikovo village of Tutaevskii area in Yaroslavl region. Her Father at that time was a tractor-driver in collective farm, and the Mother was working in a textile factory.

When Valentina was seventeen she began working as a cord-maker at a Yaroslavl tyre factory. But soon changed-over to a job of a smoother in a factory of technical cloth "Krasnyi Perekop, where her Mother and elder sister were employed. The willfull inquisitive girl strives to get an education. Without leaving her job she begins studying in a school of working youth, and then by a correspondence course in a textile technical school. She finished it in 1960 and received a diploma of technologist in cotton spinning.

At the factory Valentina joined comsomol (communist youth party). Since 1962 she is a member of the Communist Party. She was respected by the young workers at the factory for being a social worker and a leader in production. She is a member of the Yaroslavl regional Committee of the Comsomol.

She was assisted in becoming a cosmonaut by a parachute sport, which fascinated her. She joined this sport in 1959 at a Yaroslavl areoclub. She was the organiser of the parachute sport at the factory. She made 126 jumps with parachute and has a first division certificate in this sport. In the school of cosmonauts she obtained the rank of a Junior Lieutenant.

Her Mother, brother and sister live in Yaroslavl. Her Mother is now on pension, brother works as driver. Sister is a weaver at textile factory "Krasnyi Perekop". Her Father died at the front, during the World War II.

"Pravda", 16 June 1963 (Special edition). (TASS)

RADIOGRAMS FROM ABOARD "VOSTOK-6".

While flying above the territory of the Soviet Union, Valentina Tereshkova transmitted the following radiogram:

"From aboard the spaceship "Vostok-6" I send hearty greetings and best wishes to Soviet people - people creator and warmly greet the Soviet women".

C - 11

Being above the African continent the pilot cosmonaut V. Tereshkova transmittes sincere greetings to the people of Africa, wishing them peace and happiness.

The Spaceman-Six valentina Tereshkova transmitted greetings to the people of Near and Middle East. She said:

"From aboard the Soviet spaceship "Vostok-6" I greet the people of the Near and Middle East and wish them peace and happiness".

RADIOGRAMS FROM ABOARD "VOSTOK-5".

Pilot cosmonuat Valerii Bykovskii, while flying above the Scandinavian peninsula, sent a radio message: "From aboard the Soviet spaceship "Vostok-5" I warmly greet the people of Scandinavian countries".

Being above the Asian continent, V. Bykovskii transmitted ardent greetings and best wishes to people of Asia. He sent the following radiograms:

"Greetings to industrious Mongolian, Vietnamise and Koreyan People".

"Warm greetings from aboard the Soviet spaceship "Vostok-5" to the people of India, Indonesia, Laos, Ceylon and Cambodia".

"Pravda", 17 June 1963.

TASS COMMUNIQUE SPACESHIP "VOSTOK-5" CONTINUES ITS FLIGHT.

The flight of the Soviet spaceman comr. Bykovskii continues.

At 8 hours in the morning Moscow time on the 16th of June spaceship "Vostok-5" completed 28 revolutions around the Earth.

On the previous day, 15th of June, the spaceman has fully implemented the plan of research, marked for the second day of the flight.

Having informed the Earth about his feeling perfectly fit, comrade Bykovskii went to sleep after a hard working day a little earlier than planned. The spaceman slept soundly for about 9 hours. During sleep the spaceman's pulse rate was 50-56.

In the morning on the 16th of June comrade Bykovskii woke up at a set time. He is feeling excellently. Having contacted the Earth and informing, that everything aboard the Vostok-5 is in order, the spaceman began carrying out the program of the third day of the flight beginning with morning exercises and breakfast.

In a joint flight.

The flight of spaceship "Vostok-5", piloted by Valerii Bykovskii, and of spaceship "Vostok-6", piloted by a brave daughter of the Soviet people Valentina Tereshkova, continues.

Soon after the orbital insertion spaceship "Vostok-6" passed in the direct vicinity of the spaceship "Vostok-5". The first conversation of the cosmonauts with each other took place at 13 hours. They have sent a joint report to the Central Committee of the Communist Party of the Soviet Union and to Soviet Government.

At 15 hours Moscow time on 16th of June spaceship satellite "Vostok-5" completed 33rd revolution. It has been in space now for two days and covered over one million three hundred 50 thousand km. Spaceship "Vostok-6" is doing now its first hundred thousand km of orbiting. Valentina Tereshkova has now been in space for two hours.

During the second day of his flight Bykovskii continued prescribed by the program physiological tests and scientific research. The spaceman observed surface of the Earth, horizon, cloud cover, Sun, Moon, stars. The condition of spaceman as previously very good. He informs, that his appetite is excellent and the mood cheerful.

In the evening on the 15th of June picture of Spaceman-Five Bykovskii was transmitted several times on Central television and Intervision. The last television session found Bykovskii asleep.

On the 16th of June at 14 hours the viewers saw for the first time transmission from aboard the spaceship "Vostok-6". At this time Valentina Tereshkova was conversing by radio with Earth. She informed, that she is feeling very well.

The conditions in space cabins are maintained within the fixed limits. The joint flight of the Soviet cosmonauts is proceeding successfully.

At 19 hours Moscow time on the 16th of June spaceship satellite "Vostok-6" with spacewoman Valentina Tereshkova has completed five revolutions around the Earth.

Comrade Tereshkova feels quite fit. Mean pulse rate is 80, respiration 20. Weightlessness does not bother her. This was seen on the screens of televisors during the flying past of "Vostok-6" on the second and third revolutions above the Soviet Union territory.

On the first revolution Valentina Tereshkova had her breakfast, on the third revolution - lunched.

Temperature in the cabin of "Vostok-6" - 23.6^{o}, relative humidity - 34%, pressure - 770 mm of mercury.

The Soviet spaceships satellites contine their joint flight. At 22 hours on the 16th of June spaceship "Vostok-5" completes its 38th revolution, spaceship "Vostok-6" - seventh revolution. On 16th of June orbital parameters of "Vostok-5" are as follows: altitude at perigee 168.4 km, altitude at apogee - 208.3 km, orbital period - 88.06 min.

The orbital parameters of "Vostok-6" according to verified data are the following: altitude at perigee 181 km, at apogee - 231 km, orbital period - 88.3 min.

Both Valerii Bykovskii and Valentina Tereshkova feel well. All the systems of "Vostok-5" and "Vostok-6" function normally. Temperature in the cabin of "Vostok-5" - 16°C, pressure - 780 mm of mercury, relative humidity 60%. For "Vostok-6" respectively - 20°C, 754 mm and 34%.

During one of the television sessions Valerii Bykovskii, releasing from the harness, floated around the space cabin. His lunch coincided with another TV session. The viewers could observe him eating and drinking. The lunch menu included roast veal, white bread, sweet fresh cheese, black-currant juice and vitamin lozenges.

Due to the fact, that Bykovskii and Tereshkova took-off at different times - at 15 hours and 12 hours 30 minutes respectively, the time table of their working day also differs by about two hours. At the moment of this communication issue Valentina Tereshkova is finishing dinner and getting ready for sleep, whereas Valerii Bykovskii will dine only at 24 hours. Tomorrow a new working day awaits them both.

"Pravda", 17 June 1963.

TASS COMMUNIQUE THE PROLONGED JOINT FLIGHT OF SPACESHIPS "VOSTOK-5" AND "VOSTOK-6" CONTINUES.

A new day has begun of the joint flight of the Soviet cosmonauts Valerii Bykovskii and Valentina Tereshkova. At 8 hours in the morning Moscow time on the 17th of June spaceship "Vostok-5" completed over 44 revolutions around the Earth, spaceship "Vostok-5" - over 13 revolutions.

Valentina Tereshkova woke up today at 6 hours 10 minutes in the morning, got in touch with the Earth and informed, that she slept well, feeling perfectly fit. The checking of pulse, which was continuous during her sleep by means of telemetry, shows, that the sleep was sound pulse rate 52-54.

Valerii Bykovskii woke up at 7.30 in the morning in good mood and feeling well. His pulse rate during sleep - 46-50. Both began their day with physical exercises before proceeding with implementation of the flight program.

All systems of both the spaceships operate normally, fixed hygienic conditions are maintained in space cabins.

The fourth space day begun for Valerii Bykovskii and second space day of Valentina Tereshkova.

On the 17th of June in the morning both the cosmonauts had a long radio-communication with Earth. They reported on the working of the spaceships systems, reading of control instruments on temperature, pressure and air composition in the cabins. From the Earth a number of technical instructions were transmitted on the most expedient working conditions of individual systems.

The cosmonauts continue punctually to implement the flight program and give detailed descriptions of their well-being and impressions, connected with the space flight.

On recommendation from the Earth the cosmonauts reduced the air temperature in the space cabins. Now the temperature in the cabin of "Vostok-5" is 15°C, "Vostok-6" - 18°C. The analysis of the cosmonauts reports and telemetry data shows, that the systems of both the spaceships function efficiently.

Valerii Bykovskii and Valentina Tereshkova maintain radio-contact with each other.

At 15 hours Moscow time on the 17th of June spaceship "Vostok-5", piloted by Bykovskii completed during the three days of space flight 49 revolutions around the Earth, covering distance of over two million km. The joint flight of spaceships "Vostok-5" and "Vostok-6" is continuing over 26 hours. During this time Valentina Tereshkove on spaceship "Vostok-6" orbited the Globe 18 times.

At 15 hours on the 17th of June orbital parameters of "Vostok-5" composed: altitude at perigee - 165 km, at apogee - 202 km, orbital period - 88.0 min. Orbital parameters of spaceship "Vostok-6": altitude at peri e - 177 km, at apogee - 225 km, orbital period - 88.2 min.

From the verified data of the flight path of spaceships "Vostok-5" and "Vostok-6", minimum distance between them on the first revolution of the joint flight was about 5 km.

During the past 24 hours the cosmonauts, besides the scientific research, conducted a two-way radio-communication. The contact between the spaceships is quite reliable.

During the first day of her flight Valentina Tereshkova transmitted greetings to the people of China, Latin America, heroic women of Cuba, people of USA and Australia. The cosmonauts feel cheerful and in the mood for work. Their appetite and sleep are good. Pulse rate of Valentina Tereshkova - 68, respiration rate - 18; of Valerii Bykovskii pulse - 60, respiration rate - 15. All the systems of spaceships "Vostok-5" and "Vostok-6" operate normally. Pressure, temperature, humidity and air composition in space cabins are within the norm.

Fourth working day of Valerii Bykovskii in space is coming to a close. Cosmonaut-Six Valentina Tereshkova completed program of the second day of the flight. At 22 hours Moscow time on the 17t of June spaceship satellite "Vostok-5" was completing 54th revolution around the Earth. The spaceship of Valentina Tereshkova "Vostok-6" at this time, having covered in space about 900 thousand km, was making 23rd revolution.

The cosmonauts feel fit, they became fully adapted to working conditions in space and carried out today a large volume of scientific observations in total conformity with the programs.

Valerii Bykovskii and Valentina Tereshkova inform each other on the progress of flight. They exchange information on the working of equipment and the systems of spaceships, as well as information, received from the Earth. During their flight they regularly communicate with Earth. The quality of space communication is excellent.

The telemeasurements data confirm, that all is in order aboard the spaceships. Pressure, temperature, humidity and air composition in space cabins are normal.

The joint space flight of Soviet spaceships continues.

"Pravda", 18 June 1963.

GREETINGS FROM ABOARD THE SPACESHIPS.

At the moment of "Vostok-6" passing above the territory of the Soviet Union, Valentina Tereshkova greeted Lenin's komsomol.

"Warmest regards from space to the Lenin's Communist Youth, in the ranks of which I grew up" - says the radiogram.

"Hearty greetings to the peoples of Asia" - was the radio-message of Valentina Tereshkova from aboard the spaceship "Vostok-6", when it was passing above the Asian continent.

While flying above China, Valentina Tereshkova sent the following radio-gram:

"Being above your country, I send warmest regards from aboard the Soviet spaceship "Vostok-6" to multimillion people of China".

While flying above the American continent, Valentina Tereshkova directed the following radiograms from aboard the spaceship "Vostok-6":

"Peace and happiness to the peoples of Latin America.

Sincere regards to heroic people of Cuba, glorious Cuban women.

Best wishes for peace and happiness to the people of United States of America".

Flying above the Scandinavian peninsula, Valentina Tereshkova directed the following radiogram from aboard the spaceship satellite "Vostok-6":

"Warmest greetings to the people of Scandinavian countries".

Cosmonauts Valentina Tereshkova and Valerii Bykovskii jointly addressed the nations of the world from aboard their spaceships. Their message from space says: "We wish all nations on Earth a stable peace and happiness".

"Pravda", 18 June 1963.

TASS COMMUNIQUE THE UNPARALLED FLIGHT OF SOVIET SPACESHIPS CONTINUES.

This is the third day of the joint space flight of Valerii Bykovskii and Valentina Tereshkova.

By 8 o'clock in the morning on the 18th of June spaceship "Vostok-5" completed 60, and the spaceship "Vostok-6" - 29 revolutions around the Earth. By this time "Vostok-6" has covered in space one million 200 thousand km.

At night the cosmonauts were asleep. Their sleep lasted for 7 hours.

The working day of Cosmonaut-Six Valentina Tereshkova begun at 5 hours 50 minutes Moscow time. Valerii Bykovskii woke up at about 7 o'clock. They reported to the Earth on the normal procedure of flight, good performance of all the systems and about their own well-being.

Data of telemetric checking prove, that all the systems of "Vostok-5" and "Vostok-6" are in good working order. The recordings of different parameters, characterising the state of the cosmonauts and received during the night, were processed. The decoding results show, that the sleep of both the cosmonauts was sound and restful. Pulse rate of Valerii Bykovskii was 45-52, of Valentina Tereshkova - 52-60.

Pressure, temperature and air composition of the cabins are maintained automatically.

An extensive network of measuring centres continuously follows the course of the flight. Besides the telemetric information of the working of systems and the state of the cosmonau[illegible] the Coordination centre regularly receives data of orbital measurements. From these data, processed on electronic computers, the changes are checked of the orbital parameters.

The Soviet spaceships "Vostok-5" and "Vostok-6" continue their flight.

At the end of the fourth day of its flight, at 15 hours Moscow time on the 18th of June, spaceship "Vostok-5" orbited the Earth for the 66th time, having covered distance of over 2.6 millions km. Its orbital period is 87.8 min; altitude at perigee 159 km, at apogee - 193 km.

Valerii Bykovskii has been in flight now for 96 hours. This already exceeds the time of Andriyan Nikolaev's space flight on "Vostok-3".

During the four past days a large amount was carried out aboard "Vostok-5" of scientific research, special experiments, vestibular and physiological tests, observations of Earth surface, its cloud cover, stars, Moon.

Important data were obtained on the possibility of establishing direct radio-communications in short and ultrashort wave bands.

The faultless performance of the numberous devices and systems of the spaceship "Vostok-5" during the four days prove their high reliability.

For the spaceship "Vostok-6", piloted by Valentina Tereshkova, it is the third day in the orbit. Its orbital period is 88.1 min; altitude at perigee 174 km, at apogee 218 km.

Having completed 34th revolution around the Earth and covering over 1.4 million km in space, the brave Soviet girl-cosmonaut on spaceship "Vostok-6" has one and a half times exceeded the space flight of American spaceman Cooper.

Valentina Tereshkova, just as Valerii Bykovskii, carries out in space a large amount of research. All the systems and equipment of spaceship "Vostok-6" operate normally.

The conditions maintained in space cabins are the most suitable for work and rest of the cosmonauts.

Both the cosmonauts feel perfectly fit.

The flight continues.

On the 18th of June on board of spaceships "Vostok-5" and "Vostok-6" a greeting was transmitted to Valerii Bykovskii and Valentina Tereshkova from the Plenary Session of the Central Committee of CPSU opened in Moscow. The cosmonauts in reply radiogram thanked the participants in the Plenary Session for their kind regards.

At 14 hours 34 minutes a telegram was transmitted aboard the "Vostok-5", that the Central Committee has examined the application of Bykovskii about his admission into CPSU and decided to admit him as a member of CPSU.

In the answering radiogram the cosmonaut assured the Central Committee, that he will justify the trust, shown to him.

At 22 hours on the 18th of June the spaceship "Vostok-5" was in its 71st revolution around the Earth, having covered about 3 million km in space. This distance has not as yet been flown by any of the spacemen. Valerii Bykovskii is successfully coping with the flight program and feels quite fit; his pulse is 60-68, respiration - 16-18.

Spaceship satellite "Vostok-6", piloted by Valentina Tereshkova, was at 22 hours on the 18th of June in its 40th revolution around the Globe. The daily working program in flight has been completed.

Soon Valentina Tereshkova will lay down to sleep. The Cosmonaut-Six is feeling well; her pulse is 64-76, respiration - 18-20.

All systems aboard the spaceship-satellites operate normally. Temperature, pressure and humidity in the cabins are maintained within the preset limits.

An efficient working have shown the numerous ground centres of communication, flight control and reception of information from aboard the spaceships. The received data were immediately processed.

The third day of the joint space flight is coming to a close.

"Pravda", 19 June 1963.

TASS COMMUNIQUE SPACESHIPS LANDED AT THE SAME LATITUDE:

The joint space flight of the spaceship satellite "Vostok-6", piloted by the first in the world spacewoman citizen of USSR Valentina Vladimirovna Tereshkova, and spaceship satellite "Vostok-5", piloted by spaceman citizen of USSR Bykovskii Valerii Fedorovich, has been successfully completed.

In accordance with the joint flight program spaceships "Vostok-6" and "Vostok-5" landed on the 19th of June in prescribed areas of the Soviet Union.

Spaceship "Vostok-6" landed at the calculated 49th revolution at 11 hours 20 minutes Moscow time 620 km north-east of the Karaganda town.

Spaceship "Vostok-5" landed in the calculated 82nd revolution at 14 hours 06 minutes 540 km north-west of Karaganda.

In accordance with calculations both the spaceships landed at the same latitude - 53°.

At landing places the heroes were met by groups responsible for landing, friends, doctors, journalists and sport commissars.

The cosmonauts Valentina Tereshkova and Valerii Bykovskii feel quite fit.

"Pravda", 20 June 1963.

TO COMMUNIST PARTY AND PEOPLE OF THE SOVIET UNION:

TO PEOPLE AND GOVERNMENTS OF ALL COUNTRIES:

TO THE WHOLE PROGRESSIVE MANKIND:

Address of the Central Committee of CPSU, Presidium of the Supreme Council USSR and of the Government of the Soviet Union.

Another great space epic has been crowned with a brilliant success. The heroic Soviet cosmonauts Bykovskii Valerii Fedorovich and Tereshkova Valentina Vladimirovna have accomplished on marvelous spaceships satellites "Vostok-5" and "Vostok-6" a many-days joint space flights and have safely landed on the territory of our Motherland - Union of the Soviet Socialist Republics.

Placed into orbit on the 14th of June spaceship satellite "Vostok-5", piloted by valiant son of the Soviet people communist comrade Bykovskii, has during 119 hours orbited the Globe 81 times and covered a distance of over 3 million 300 thousand km.

On the second day in space of the spaceship "Vostak-5", another spaceship was placed into orbit on the 16th of June 1963 - "Vostok-6", piloted by heroic daughter of the Soviet people, communist comrade Tereshkova.

"Vostok-6" during 71 hours has orbited our planet 48 times and covered a distance of about 2 million km.

This outstanding space flight has extended the limits of our knowledge of the Universe, has proved once more the reliability and perfection of our spaceships, created by the talented Soviet scientists, designers, engineers, technicians and workers. The unparalled duration of being a man in space has enriched the science with new data, which are invaluable for the forthcoming flights into distant spaces of the Universe, for further development of science and technique. The new prolonged joint flight in space of spacehip-satellites "Vostok-5" and "Vostok-6" is a glorious victory of labour, thought and mind of the Soviet man - initiator of the space era, a collosal breakthrough. This daring flight of the Soviet people into space, like all the preceding flights, is a living embodiment of titanic power, talent power, talent and genius of the Soviet people, a brilliant demonstration of the advantages of the Soviet socialist order. Today's majestic victory, gained in the struggle for the mastery of space, is an example of unparalled courage and daring of Soviet people, brought up by our Communist Party, inspired by all-conquering ideas of Marxism-Leninism.

The Soviet social order called into life the powerful forces of people, raised it to great accomplishments. In achievements of Soviet economics, in the impetous upward flight of technology, in successful economic competition with capitalism, in the growth of a new man - in all that is great and beautiful, which is created on our earth, we and all our friends abroad see triumph of the Marx-Lenin ideas, triumph of socialist order.

Progressively further and deeper penetrates into space secrets the creative thought of the Soviet man, distant planets and stars become progressively nearer. Every new route, paved by Soviet people into space, is a brilliant proof, that the Soviet science and technique firmly hold their forward position, won by the Soviet people in the struggle for conquering the outer space for peaceful purpose.

In this joyful and solemn hour Soviet people with a feeling of great pride and admiration recall, that it is our countrymen, who were the first to penetrate into space distances, that the dawn of the space era began on our Earth. Soviet Union was the first to place into orbit the artificial Earth satellite, was the first to deliver a USSR pennant to the Moon, first to send into space the spaceship satellite with animals, first to send a man along the untrodden spaceways and attained great victories, which are applauded by the whole progressive mankind.

Today into the glorious chronicle of heroic mastering of space next to the names of Yurii Gagarin, Herman Titov, Andriyan Nikolaev and Pavel Popovich the Soviet people have written in new names in gold letters - Valerii Bykovskii and Valentina Tereshkova.

The successfully completed prolonged joint space flight is remakrable by the fact, that the commander of the spaceship satellite "Vostok-6" was the heroic daughter of our Motherland, citizen of the Union of Soviet Socialist Republics, first in the world spacewoman comrade Tereshkova Valentina Vladimirovna. The feat of comrade Tereshkova multiplied the great glory of the Soviet woman - indefatigable workers, active fighters for the peace and happiness of nations, builders of communism.

The glorious son and daughter of our Motherland comrades Bykovskii and Tereshkova have shown true heroism and faultless skill of cosmonauts, valiantly and fearlessly led their marvelous spaceships along the cosmic routes. The Communist Party and Soviet people are proud of you, dear comrades Bykovskii and Tereshkova!

Pilots cosmonauts, scientists, designers, engineers, technicians and workers, all those who participate in construction of magnificent spaceships satellites and in the accomplishment of the many-days space flights, fruitfully labored for success of these composite flights, have carried out with honor their duty to Motherland.

Less than six years have passed since the launching in the Soviet Union of the first artificial Earth satellite, but what a great progress our country has made in the mastering of space. All achievements of the Soviet Union and its heroic people in the sphere of space research and conquest serve the progress of mankind, the great cause of peace on Earth. Our red-star spaceships fly above the Earth as messengers of peace, as embodiment of the peaceful striving of the Soviet people - builders of communism.

We appeal to the Governments of all the countries, to all the peoples of our planet to stop the armament race, to implement general and total disarmament, to struggle persistently for the cause of peace in the world. Let the greatest achievements of the human genius and scientific discoveries serve the noble cause of peace.

Soviet people by its heroic labor raises the shining building of communism, indefatigably strenghtens the might of its socialist power. In unbounded spaces of our Motherland the persistent constructive labor of the millions of the new world builders is in full swing. The feat of courageous pilots cosmonauts comrades Bykovskii and Tereshkova inspires the Soviet people to new victories in the building of cummunism.

Glory to the Soviet people - builders of communism!

Glory to heroic conquerors of space!

Forward, to the triumph of peace and progress!

Central Committee of CPSU	Presidium of the Supreme Council of USSR	Council of Ministers of USSR.

An Outstanding Contributi... to Universal Science.

To scientists and designers, engineers, technicians and workers, to all groups and organizations, participating in the accomplishment of prolonged joint space flight of "Vostok-5" and "Vostok-6".

To Soviet pilot cosmonauts comrade Bykovskii, comrade Tereshkova.

Dear comrades!
Dear countrymen and countrywomen!
During these days another glorious page has been written in the history of space mastering, a new important step made in uncovering by a man of the mysteries of the universe.

A special joy and pride is roused in the Soviet people by the fact, that this time also the prolonged joint flight in difficult conditions was accomplished on spaceships "Vostok-5" and "Vostok-6" by citizens of the Union of Soviet Socialist Republics comrade Bykovskii Valerii Fedorovich and comrade Tereshkova Valentina Vladimirovna.

Unparalleled in its significance is the feat of pilots cosmonauts Valerii Bykovskii and Valentina Tereshkova. In the prolonged joint flight the cosmonauts carried out an extensive program of scientific research, new contribution was made into the treasury of the world's science and culture. The mankind will always recall with pride the names of Yurii Gagarin, Herman Titov, Andriyan Nikolaev, Pavel Popovich, Valerii Bykovskii and the first in the world woman-cosmonaut Valentina Tereshkova.

Whole-heartedly we congratulate you dear comrades Bykovskii and Tereshkova with successful completion of a new joint space flight. The Motherland is pround of your great feat, which has multiplied the fame of the Soviet people and enriched the science.

The spaceships satellites "Vostok-5" and "Vostok-6", created by our scientists, designers, engineers, technicians and workers, have successfully passed every test in the most difficult contitions of space flight. Throughout the whole flight the equipment of "Vostok-5" and "Vostok-6" performed efficiently and unfailingly.

In unparalleled feat of comrades Bykovskii and Tereshkova the genius was manifested with a new force of the Soviet people people-fighter, people-worker. The whole world has become once more convinced of inexhaustible advantages of socialist order over the capitalist, the might and greatness has been demonstrated of our Motherland - Union of the Soviet Socialist Republics.

Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of USSR and the Council of Ministers USSR warmly congratulate scientists, designers, engineers, technicians, workers, medical personnel-all, who participated in construction of spaceships satellites "Vostok-5" and "Vostok-6", in preparation and successful accomplishment of the joint space flight.

Glory to Soviet scientists, designers, engineers, technicians and workers - creators of marvelous spaceships!

Glory to valiant Soviet cosmonauts!

Glory to heroic Soviet people - builder of Communism!

Glory to the Communist Party of the Soviet Union - inspirer and organizer of all the victories of the Soviet people!

Forward, to the victory of communism!

Central Committee of CPSU	Presidium of the Supreme Council of the USSR	Council of Ministers USSR

"Pravda", 20th June, 1963.

Tass Communique Program Fully Implemented.

The joint flight of spaceships satellites "Vostok-5" and "Vostok-6" is successfully completed.

The spaceship "Vostok-5", piloted by V.F. Bykovskii, took-off on the 14th of June at 15 hours Moscow time and, in accordance with the program, after a five-day space flight, landed on the 19th of June at 14 hours 06 min in prescribed area on the territory of the Soviet Union. The spaceship "Vostok-5" was over 119 hours in flight, made over 81 revolutions around the earth and covered a distance of over 3 million 300 thousand km.

The spaceship "Vostok-6", piloted by the first in the world woman-cosmonaut V. Tereshkova, took off on the 16th of June at 12 hours 30 minutes. In accordance with the set problems launching of "Vostok-6" was implemented during the orbiting of spaceship "Vostok-5".

According to program the joint flight of spaceships satellites continued for about three days and was successfully completed on the 19th of June. The spaceship "Vostok-6" landed at 11 hours 20 minutes in prescribed area on the territory of the Soviet Union. The spaceship was in flight for 71 hours, having completed during this time over 48 revolutions around the earth and covering a distance of about 2 million km.

During the flight the cosmonauts controlled the spaceships, checked performance of the systems, conducted research and observations of earth surface, cloud cover of the earth, observations of the sun, moon and stars. Throughout the flight they regularly carried out physiological, vestibular and psychological tests and special exercises in conditions of weightlessness.

A reliable two-way radio-communication was maintained between "Vostok-5" and "Vostok-6". During the flight the cosmonauts exchanged results of observations. Radio-contact of spaceships was quite stable.

All the systems of the spaceships, as well as the ground stations of flight control functioned faultlessly. The reliable performance of telemetric and television equipment enabled to keep up constant checking of the state of the cosmonauts and performance of the systems. The ground measuring complex provided measurements and timely processing of data on the flight trajectory of spaceships.

The descent and landing systems of the spaceships performed efficiently and coordinately.

The telemetric data of medical checking and visual TV observations of the state of the cosmonauts, conducted throughout the flight, have shown, that the cosmonauts Bykovskii and Tereshkova stood well the orbital insertion, the many-days space flight and return to earth. After the space flight and landing both the cosmonauts feel quite fit. At present they are resting and are undergoing medical examination.

The extensive program of space research is fully implcmented. New valuable data were obtained on the effect of various factors in prolonged space flight on the organism of a man and woman. Extensive medico-biological investigations have been conducted. Considerable actual material was obtained, required for further improvement of the systems in piloted spaceships.

The joint flight of comrades Bykovskii and Tereshkova is a new contribution to the cause of peaceful mastering of the outer space, once again indicates high level of achievements in the national science and technique and heroism of the Soviet people.

"Pravda", 20th June, 1963.

Decree of the Presidium of Supreme Council of USSR on Conferring Title Hero of the Soviet Union to Pilot Cosmonaut Comrade Bykovskii V.F.

For accomplishment of prolonged space flight on spaceship satellite "Vostok-5" to confer the title Hero of the Soviet Union with award of the Order of Lenin and medal "Gold Star" to pilot cosmonaut comrade Bykovskii Valerii Fedorovich.

L. Brezhnev
Chairman of the Presidium of the Supreme Council, USSR

M. Georgadze
Secretary Presidium of the Supreme Council
of USSR.

Moskva, Kremlin, 22nd June, 1963.

Decree of the Presidium of Supreme Council of USSR on Conferring Title "Pilot Cosmonaut USSR" on Comrade Bykovskii V.F.

For accomplishing a prolonged space flight on spaceship satellite "Vostok-5" to confer title "Pilot-cosmonaut of USSR" on the citizen of Soviet Union comrade Bykovskii V.F.

L. Brezhnev
Chairman Presidium of the Supreme Council
of USSR.

M. Georgadze
Secretary Presidium of the Supreme Council
of USSR.

Moscow, Kremlin. 22nd June, 1963.

Decree of the Presidium of the Supreme Council of USSR on Conferring the Title Hero of the Soviet Union on Pilot Cosmonaut Comrade Tereshkova V.V.

For accomplishing a prolonged flight on spaceship satellite "Vostok-6" to confer the title "Hero of the Soviet Union" and award of the Order of Lenin and medal "Gold Star" to first in the world woman cosmonaut comrade Tereshkova

Valentina Vladimirovna and to erect a bronze bust of the Hero in the city of Moscow.

L. Brezhnev

Chairman Presidium of the Supreme Council of USSR.

M. Georgadze

Secretary Presidium of the Supreme Council of USSR.

Moscow, Kremlin, 22nd June, 1963.

Decree of the Presidium of the Supreme Council of USSR on Conferring the Title "Pilot-Cosmonaut USSR" on Comrade Tereshkova V.V.

For accomplishment of prolonged flight on spaceship satellite "Vostok-6" to confer the title "Pilot-Cosmonaut USSR" on the citizen of Soviet Union comrade Tereshkova V.V.

L. Brezhnev

Chairman Presidium Supreme Council of USSR

M. Georgadze

Secretary Presidium Supreme Council of USSR

Moscow, Kremlin. 22nd June, 1963.

"Pravda", 23rd June, 1963.

Press-Conference on the Successful Flight of Spaceship "Vostok-5" and "Vostok-6".

The Assembly Hall of the Moscow State University, where the press-conference is being held, is overful. There are correspondents of Soviet and foreign newspapers, radio and television. Present also foreign diplomats, stationed in Moscow.

In presidium jointly with cosmonauts are the outstanding Soviet scientists. They are entitled, just as the cosmonauts, to the laurels of the new brilliant victory of the Soviet people.

The press-conference is inaugurated by M.V. Keldysh, President of the Academy of Sciences USSR.

Decisive step to Mastering the Secrets of the Stellar Worlds. Address of M.V. Keldysh.

Dear Comrades, gentlemen!

On the 14th of June, 1963 began the unparalleled space flight of the spaceship-satellite "Vostok-5", piloted by the USSR citizen Lt. Col. Valerii Fedorovich Bykovskii.

On the 16th of June, 1963 spaceship satellite "Vostok-6" was placed into the earth orbit, piloted by the first in the world woman cosmonaut Valentina Vladimirovna Tereshkova.

The unequalled feat, accomplished by Valentina Tereshkova and Valerii Bykovskii, once more demonstrated to the world the fearlessness and courage of the Soviet people, the grandeur of the concept of the Soviet scientists and their capacity to make this concept an actuality. The world have seen with their own eyes, that a woman equally with man is capable of creating miracles not only on earth, but also in space.

In the Soviet country, where from the start a full equality was established of men and women, there are well-known names of women, who made marvelous discoveries in science, had notable achievements in art, who accomplished heroic feats in labor, became notable statesmen.

In our epoch space flights rivet the attention of the whole world. The first woman, who accomplished a space flight, is a citizeness of the Soviet Union Valentina Tereshkova. The flight program of Valentina Tereshkova was estimated for one day with possible continuation upto three days. As we know, Valentina Tereshkova implemented the maximum program, having retained her efficiency and showing courage, worthy of a Soviet woman. Her stellar trip lasted 71 hours, she completed 48 revolutions around the earth and covered during this time about two million km.

The flight of Valerii Bykovskii lasted 119 hours. During this time he covered a distance of over three million three hundred thousand km. To Valerii Bykovskii belongs the record in distance and duration of space flight. The distance and duration attained in this flight proves the enormous progress of the Soviet rocket-construction, based on the achievement of the whole Soviet science and technique.

Firmly retained by the Soviet Union the priority in the sphere of mastering the outer space is the result not only of the mighty industrial base, perfect technique, superiority in a number of leading branches of science, but is also the result of the greatness of ideas inspiring Soviet people - idea of constructive labor for the good of progress and general peace.

By constructing the best in the world spaceships, laying down the space routes, step-by-step learning the secrets of the Universe, the Soviet people are convinced, that their contribution to the cause of science is simultaneously contribution to the cause of the general peace.

In the appeal, published recently in connection with the flights of Valerii Bykovskii and Valentina Tereshkova, of the Central Committee of CPSU, Presidium of the Supreme Council of USSR and the Council of Ministers USSR, to nations and

Governments of all countries and to the whole progressive mankind it is again emphasized, that the Soviet space research serves only peaceful purpose, that the flights of our spaceships satellites are the embodiment of peaceful aspirations of the Soviet people - builders of communism.

The new outstanding achievements in the sphere of space flights prove the high constructive perfection of spaceships "Vostok-5" and "Vostok-6", abroad which all the conditions were created for a long safe man-in-space flight, for a safe landing in prescribed area, for the conduct of a serious research in space.

The flights of space pioneers Yu. A. Gagarin and G.S. Titova, first in the world group flight of A.G. Nikolaev and P.R. Popovich open out not only the prospects of prolonged space flights, but also make it possible to conduct space research. A number of valuable scientific investigations were implemented on spaceships satellites "Vostok-5" and "Vostok-6". With each new manned space flight the sphere of research gets expanded, the possibility opens out for such investigations, as the study of the Sun in various regions of the spectrum, extra-atmospheric photographing of stars and constellations, observation of the earth's cloud cover, optical properties study of the earth's atmosphere, growth study of living forms in conditions of weightlessness, as well as the study of a number of other phenomena.

Spaceships "Vostok", which for the first time made it possible for a man to accomplish space flight, are the prototype of the future liners for prolonged space travel, interplanetary orbital stations, scientific laboratories with people in space, in which the scientists will continue the study of the universe.

The achievements of radio-electronics made possible the direct transmission of the cosmonauts TV picture from space to the screens of our televisions, a continuous radio-telephone contact was established with the spacemen. The spaceman could at his own discretion maintain in space cabin the required temperature, easily control the ship, leave his seat and float in conditions of weightlessness unusual for a man. It may be said, that the whole flight of Valerii Bykovskii and Valentina Tereshkova, from takeoff till the landing, proceeded in accordance with exactly planned program. This is due to enoromous number of scientists designers, workers, who prepared and launched the spaceships "Vostok-5" and "Vostok-6", this is due to our space heroes - Valentina Tereshkova and Valerii Bykovskii.

However, fantastic it may be, but the mankind has made a most decisive step toward the mastering of secrets of the stellar worlds, toward reaching the planets of the Solar System. The Soviet spacemen Yu. A. Gagarin, G.S. Titova, A.G. Nikolaev, P.R. Popovich, V.F. Bykovskii, V.V. Tereshkova have laid the first space ways. Our socialist motherland, building under the leadership of Lenin's Party its communistic future, is the cradle of all these great achievements, and the Soviet people - captains of the first spaceships.

Dear Valerii Fedorovich and Valentina Vladimirovna! Your historic flight has excited the world's nations, your names can be heard throughout the continents. The Party and the Government, Soviet people highly value your immortal feat. You have been conferred the title of heroes of the Soviet Union and Pilots-Cosmonauts of USSR.

Permit me to welcome you in the name of the Academy of Sciences, in the names of all the scientists of the Soviet Union, from all those assembled in this Hall.

The Academy of Sciences of the Soviet Union, taking into account the outstanding value of your flight to the science, to cosmonautics, has awarded to you gold medals, bearing the name of our great countryman, outstanding scientist, who formed the scientific basis of cosmonautics, Constantin Eduardovich Tsiolkovskii.

It is my great pleasure to hand you these medals!

New Technological Problems have been resolved.
Address of Blagonravov A.A., Academician.

Dear comrades, Ladies and Gentlemen!

Great interest is caused in the world by a new step in the extensive mastering of space, accomplished as a result of heroic feat of two new Soviet cosmonauts - V. Tereshkova and V. Bykovskii.

In front of our eyes, during a very short period, unfolds by seven-mile steps progressively deeper and more precise space research.

During this period the intellect of scientists and engineers has accomplished gigantic work, resolving enoromous amount of scientific and technical problems.

The new space flight, that of Tereshkova and Bykovskii, is a new breakthrough in the mastering of space.

I will try in my address to tell of some examples, which distinguish the last space flight from the preceding, making, however a reservation, that to estimate fully everything new provided by this flight to science, will be possible after a considerable time, required for processing a large amount of material, obtained during this flight.

Perhaps, no where else the characteristic features of science development are so clearly defined as in space research. The true science we assume to be that, which aims at the good of the human society. But frequently at the dawn of development of a new branch of science it is impossible to foreese the use, which further development of this branch of science may bring to mankind, and only in the development process itself can be clarified its practical applications. Thus it was, for instance, in the development history of radio-engineering and electronics. Thus it is also in the space science.

The first steps in the space research were purely in pursuit of knowledge, satisfying the thirst for knowing the nature, which is inherent in a man, and the investigators, perhaps, never thought of any practical purpose. But already at present, in spite of the extreme newness of the new scientific trend, some ways were found for the practical application of the artificial earth satellites for improving weather service, for development and improvement of distance radio-communication and television on a global scale. We cannot say now quite definitely,how many andwhat benefits will bring to mankind further development of space research, only generally these benefits were outlined by our great countryman K.E. Tsiolkovskii, but the fact, that the development of this new sphere of science will be most beneficial for mankind is undoubtful.

The second characteristic feature in the process of science development is the fact, that each new achievement opens out new prospects and new ways for further achievements, and at the same time the means are being developed for new achievements. Undoubtedly, even the present space flight will arm the investigators for paving new ways, for setting up new problems, same as the experience of previous flights made it possible to carry out more perfect and reliable preparation for the space flight of Tereshkova and Bykovskii.

The safety of each space flight depends a lot on the estimate of environment in space, where the flight is to take place. Knowledge obtained at present in space physics enables to estimate the effect of such factors, as cosmic and solar radiation; sufficient knowledge has been accumulated regarding density and energy spectrum of meteor showers, of density effect on the flight of spaceships of the upper atmospheric layers, etc. All this enables to provide the necessary measures for ensuring the flight and safe return of cosmonauts to earth. The successful completion both of the present flight and all the preceding ones shows with all the manifestness the efficiency of measures taken and brilliant resolution of composites problems for the complete safety of flights.

It should be added, that ensuring the flight of Tereshkova and Bykovskii required, for instance, careful observation of the solar activity prior to takeoff. The service of astronomical observatories was enlisted for this purpose. By means of geophysical rockets investigation was made of the upper atmosphere vertical section, which enables to estimate the conditions at the current moment.

I shall mention briefly some differences of the last space flight in comparison to the others.

The considerable expansion in the program of medico-biological investigations, which add to our knowledge of the effect of all the flight conditions on human organism, will be discussed in the address of V.I. Yazdovskii. I shall only mention, that considerable improvements were made in the life support systems, which made it possible for the cosmonauts to define their time in space, as the time in "comfort zone".

The difference in the present flight is also the fact, that, if in the previous cases the main attention was concentrated on the study of the effect of flight conditions on the human organism, in this case it was possible to include in the flight program side-by-side with medicobiological investigations a number of scientific observations: observations of constellations photographing of the sun, photographing the edge of the earth's disc at sunrise and sunset, visual and optical observations from space of the earth's surface.

The cosmonaut V.F. Bykovskii took advantage of the possibility to observe the spaceship of his companion to determine orientation of his own spaceship in relation to other cosmic objects.

In order to show, how far was the present flight a new step, I shall use, as an example, some changes, made for this flight in transmission systems of TV pictures and communication systems.

The numerous TV viewers, who had the possibility to follow on their screens many details in behavior of the cosmonauts during the flight, can appreciate the improvement in quality of TV transmission from the space. In order to make available the TV pictures to the general public, from time to time the pictures, received at several reception stations, were projected onto transmitting tubes, and the amplified signals transmitted along the surface communication lines to Moscow TV center. Next along the radio-relay and cable lines the pictures were transmitted into intervision and eurovision systems. In the development of the TV equipment on board a number of difficulties were overcome, connected with assuring a good quality of pictures. For instance, the problem was resolved of a uniform lighting of cabin, so that when the cosmonaut leaves his seat the lighting would not deteriorate; automatic adjustment was also attained of the brightness of picture in the case the lighting changes, special high-aperture optics were developed. For narrowing the width of frequency spectrum in transmission on spaceship-earth channel, the use was made of lower picture frequency. The incoming synchronization signals were regenerated at the Moscow TV center, so as to reduce the distortions, origination in transmission lines.

The performance was excellent of communication system between the ships, as well as of the ships with earth, both on short and ultrashort waves. For the first time duplex radio-communication was used on ultrashort waves; filters were used in the equipment abroad, which enabled the cosmonauts to receive radio-signals from earth with simultaneous operation of transmitter on board without any interference. The ground network of radio-communication was considerably expanded, and this ensured both the quality and long range of transmission.

The communication between the spaceships was fully assured within the range of visibility, i.e. practically at a distance of several thousand km. During the flight the transmission of a very considerable amount of information was accomplished; it is enough to point out, that this amount exceeded that, transmitted by Nikolaev and Popovich during their flight. The reliable contact with earth was available also at the time, when the cosmonaut left his seat, which was obtained by the microphones and reproducers being fitted in a way to get uniformity of acoustic field in the cabin.

The cosmonauts could receive broadcasting stations on various wave bands. The reliablity of communication was provided both by the duplicating devices and selection of working conditions for radio-details. It may be stated, that communication system was excellently operated by our radio operators and not for a minute did the cosmonauts feel themselves alone, cut-off from earth and from each other, which strengthend their courage even more, maintained their strength and invariably cheerful mood.

We can be sure, that the next even more distance and more composite flights of Soviet cosmonauts will be in even better conditions, since the experience of Tereshkova and Bykovskii flights will enable to introduce further improvements in the arrangement and equipment of spaceships.

Tribune - Professor V.I. Yazdovskii.

Man in Prolonged Space flight. Address of Prof. V.I. Yazdovskii.

Dear comrades! Ladies and Gentlemen!

The prolonged joint space flight of Valerii Bykovskii and Valentina Tereshkova is a brilliant achievement of the Soviet science and technique. The accomplishment of this flight required working out and resolving serious medico-biological problems.

It was preceded by a lot of research work to find the best methods for recording physiological functions of a man in prolonged flight and improving the conditions of his habitation in space cabin. This concept includes hygienic conditions of microclimate, questions of personal hygiene, food and water, etc. Naturally, preparation for the flight of a woman required conducting a number of special scientific investigations, specified by the anatomic and physiological characteristics of a female organism. In particular, a new system was developed for fixing a number of sensors for recording respiration and cardiac activity, experiments were carried out to define the stability against overstrain in relation to physiological cycles in the organism.

The main scientific problems of medico-biological investigations in the flight of V.F. Bykovskii and V.V. Tereshkova on spaceships "Vostok-5" and "Vostok-6" were the following:

- Further study of prolonged effec of space factors on the human organism.
- Study of psycho-physiological possibilities and efficiency of a human being in conditions of prolonged

weightlessness combined with other flight factors.

- Investigations of female organism reactions to effect of space flight conditions.

- Further study of daily periodicity of the physiological processes of a man in space flight.

- Effectivity study of selecti n methods and special preparation of the cosmonauts.

- Performance study of the system for medico-biological checking of the state of the cosmonauts and microclimate of the space cabin.

- Efficiency study in performance of life support system and safety means in space flight.

The state of the cosmonauts was estimated by such methods as electrocardiography, seismocardiography, pneumography, electoencephalography, electro-oculography, recording of galvanic skin reactions. The physiological information was transmitted by telemetry, and the pulse rate - additionally through a special channel of radio-transmitter "Signal", operating continuously.

The specially developed ways of spacevision in combination with radio-telephone conversations to some extent filled-in the space andtime break, which earlier existed between the doctor on earth and the crew of spaceships. If methods of the scientific checking are analyzed in terms of functional and vital systems of the organism, it is possible to say:

- Cardiac activity was checked from the pulse rate, from the structure of electrocardiogram, characterizing dynamics of heart processes, from seismocardiogram, reflecting contractability of myocardium.

- The respiration was estimated from the perimeter changes of the chest, shown on recording of the respiratory actogram. The respiration rate and depth were estimated during calm breathing and during the speech articulation.

- Psychomotor activity of the cosmonauts was estimated from a very wide range of indices, including analysis of special tests, verbal reports, movement dynamics, facial expression, movements of eyes (from electro-oculogram), appearance of changed rhythmicity waves and desynchronization on electroencephalogram and, finally, from dynamics of spontaneous changes of resistivity to galvanic current of a man's cutaneous tegmen. Checking of radiation, during the flight we conducted, by physical and biological dosimeters.

The total radiation dose during the flight composed in V.F. Bykovskii 35-40 millirad, in V.V. Tereshkova - 25 millirad.

Since the present information is based on quickly-processed data, whereas the whole extensive and carefully documented information is not yet mechanically processed, it is not possible to make any broad general conclusions. However, it may be said, that careful methodical preparation, high level of of technical equipment enabled to obtain high-quality valuable information through all the planned channels of telemetry and systems.

The pre-takeoff period in V.F. Bykovskii and V.V. Tereshkova has shown as usual some quickening of the cardiac cycle. The propulsion branch of the flight prior to orbital insertion both the cosmonauts stood well and have implemented the planned amount of activity.

During the orbital flight V.F. Bykovskii has carried out the total volume of flight assignment and of research. Four times (on 18th, 34th, 50th and 66th revolutions) he released himself from the harness and floated free in the cabin, implementing the required volume of work. In conditions of weightlessness he made sharp movements and shifting about, conducting vestibular tests and did not notice any unpleasant sensations. He noted no disorders either in the function of sight analyzer. Good appetite and sound sleep was retained throughout the flight. Physiological functions encountered no difficulties.

The state of health of V.F. Bykovskii throughout the flight was excellent and the efficiency was retained at quite a high level. The orbital flight of V.V. Tereshkova was planned for one day. Satisfactory condition of V.V. Tereshkova enabled to continue the flight upto three days. The sleep in flight removed the emotional tension and restored effeciency. With great pleasure she carried out physical exercises. Valentina Vladimirovna Tereshkova also did not notice disorders of visual function.

The pulse of V.F. Bykovskii varied during the flight from 46 to 80, and respiration rate from 12 to 22. Daily fluctuation of the cardiac cycle conformed to data, recorded in prolonged ground experiments.

The pulse rate of V.V. Tereshkova varied from 54 to 84. Considerable fluctuation of cardiac cycles were noted within short intervals, respiration rate varied from 16 to 22. Overstrain in descent branch both the cosmonauts stood well.

According to electrocardiography and seismocardiography data, there were no noticeable disorders of cardiac activity. No disturbance in respiration were observed throughout the flight.

It should be mentioned, that during the whole flight microclimate parameters in cabins of"Vostok-5" and "Vostok-6" were almost optimum. Temperature varies from 14 to 20°, humidity whthin 35-60%, carbon dioxide content - 0.5% at normal barometric pressure.

As a result of Bykovskii and Tereshkova flight an extensive scientific material has been accumulated; it will require some time for its processing and correlation.

There is no doubt, that the obtained scientific results will be a new large step in the man's mastering of space.

Thanks to Creators of Spaceship "Vostok"!

Address of V.F. Bykovskogo.

Dear comrades! Ladies and Gentlemen!

I think, that I should tell you about my flight, about the five days in conditions of weightlessness in the space cabin of "Vostok-5".

Thus, we start from the time and the place. It was on the day of the 14th of June, 1963 at the cosmodrome Baikonur. Before taking my place in the spaceship, I warmly said good-bye to those, who got me ready and were seeing me off. My mood was exalted. It was joyful to realize, that I, a member of the Komsomol, was entrusted with the great honor of carrying out a difficult assignment. Warm parting words are being said. My friends and I embrace. My fellow wishes me a happy flight. We are friends of long standing, he has a lot in common with me. In the past he was also a fighter-pilot, together we had the training for the flight and if he was entrusted with this assignment, I am sure he could have carried it out successfully.

Finally - I am in the cabin. I had lived in it and everything is quite familiar. At 15 hours Moscow time

"Vostok-5" took off from the cosmodrome. From this moment the count began of the five-days flight.

It is well known, that during the orbital insertion of the spaceship the cosmonaut experiences considerable overstrain. I too have had this experience. What can I say about it? It is hard, of course, but a well trained organism can satisfactorily stand this overstrain. I can judge it on my self. from my own feeling. I cannot say, that I felt good or excellent. But satisfactory estimate is quite sufficient in resolving such problem, as acceleration upto prescribed velocity within a limited time.

The spaceship entered an orbit close to calculated one and I felt the weightlessness - unusual for an earth-man, still little known to science. The arm muscles felt unusual lightness: you raise an arm without effort, take an object in your hand - it weighs nothing. One gets used to that, but, ofcourse, not at once. Even if you consider, that one heard about it from the cosmonaut-friends and have read a lot.

The flight began and my work for five days started. What was this work?

In accordance with the fli ht assignment I several times oriented the spaceship in flight carried out various medical tests and observations, observed the earth, horizon, moon, sun, filmed horizon, cloud cover, moon and constallations, worked with the spaceship's equipment, maintained communication with earth and spaceship "Vostok-6", free floated in the cabin, and, naturally, took my meals, rested and slept.

The spaceship gets easily oriented and is stable after orientation. The orientation could be automatic, as well as manual. In every case the orientation systems operated unfailingly.

All the medico-biological tests and observations were carried out by me in accordance with the program. I think, that the medicine will get a lot of new and valuable data.

I would like to say again, how beautiful the earth is from the space!

Observing the earth, I could see clearly rivers, seas, lakes, oceans. The water surface is highly distinct from the land. The water in the seas and oceans is of various color. The curvature of the earth's horizon is clearly noticeable. The horizon itself with exit from the earth's shadow has a beautiful range of colors, with predominance of red shades. Roads and towns could be seen on earth. Specially clearly the towns are seen at night.

During the flight I lived and worked according to program, composed on earth. I paid a lot of attention to various tests and experiments. I had my meals four times a day. The food was the usual, as on the earth. My appetite was excellent. Sleep sound. On the first day I even went to sleep before time. You can understand all the excitement and impressions, which I had. And by the way, there were a few moments in the space also. I had transmitted a routine communique, in which, in particular, I said, that I had a cosmic stool. Due to interference in radio-communication the operator at control center took instead of "stool" "stuk" (knocking). This cause a commotion at the control center. I was bombarded with questions: "What happened to the ship, what is knocking, what kind of knocking: sliding, hissing, scrapping, etc.".

Explanation had to be given, that it was a cosmic stool, or simply, that I had used the sanitary arrangement. I reply I heard a burst laughter, the comrades at the center calmed down and the work again took on a calm, busy nature.

I paid special attention during the flight to physical exercises. Besides the usual exercises, carried out by the previous cosmonauts, I did chest-expanding exercises with a rubber band. Physical exercises assisted in retaining efficiency throughout the flight.

Investigations were also conducted in flight of radio-communication on line "space - earth - space" and between the spaceships was insignificant, in our flight it varied in all directions quite considerably - from 5 km to some hundreds of km. Never-the-less, the contact between space-ships was quite stable. Naturally, with the entry into orbit of "Chaika", it atonce became more cheerful. We exchanged opinions, gave hints to each other on work and even sung. Obviously, it will be possible to fly confidently and maintain contact between the crews at great distances.

A marvelous achievement of the Soviet science and technique is the direct TV transmission "space - earch". During the TV sessions I tried to show to the people on earch, what is weightlesseness, demonstrating it by various objects in the space cabin. But generally speaking, to know what is weightlessness, onehas to fly himself.

I was specially impressed by the free floating tin in the cabin. To be frank, I waited with impatience every time for the hour, when I could release from the harness and to float around the cabin. Unharnessed I implemented various movements, floated across to the portholes, observed the earth. Very interesting - with a small push you float to the other side. When you close your eyes it is difficult to understand in what position you are. I will not use the warmest and sincere words to address our wonderful designers, scientists, engineers, technicians and workers, the mind and labor of those who have created our wonderful spaceships "Vostok". How wonderfully well operate all the systems! Full comfort is maintained in the spaceship, which assists in retaining high efficiency.

Such are the general impressions from the many-days flight on spaceship "Vostok-5". I remind, that it begun on the 14th of June. During this first day of the flight, I, so to speak, was familiarizing myself with conditions, unusual for me getting used to them, doing various assignments. I must say, that I got used very quickly to conditions of the flight. On the second revolution I transmitted a radiogram to Moscow, in which I reported to the Central Committee of the Party and the Soviet Government, that the flight is proceedinng successfully.

When the time has come I had my meal and went to sleep. I slept so soundly, that, as the saying goes, I could have been dragged out by my feet. Only there is no one to do it - in the space I am alone.

My solitude lasted for two days.

On the 16th of June I was joined in the cabin of "Vostok-6" by my space sister - Valentina Tereshkova. It became more cheerful and interesting to fly.

During the flight I listened to radio broadcast, specially from Moscow. I followed the proceedings of the plenary session of the CC CPSU. My dream for a long time was to become a communist, and I applied to the Central Committee with a request to admit me to the membership of CPSU. How glad I was, when informed that I am a communist, that the CC of the CPSU has granted my request! Once again I thank you for the trust.

I do not know, what the telemetric measurements of my pulse have shown, but, frankly speaking, I was very excited at that time. The excitement was of happiness, from the warranted feeling of pride. It was exactly with this feeling I steped onto the dear Soviet land at the end of the flight, when the program of the joint space flight was implemented. With the same feeling of pride for my Motherland, for my nation and its accomplishments, that I address you now.

Thank you for your attention.

We were not afraid of Difficulties.

Address of V.V. Tereshkova.

Dear comrades! Ladies and Gentlemen! Friends!

You can easily imagine the great joy, which I experience from realization, that I have justified the trust of the Party and Government, friends-cosmonauts, the whole Soviet people and primarily our glorious Soviet women.

I am infinitely happy and proud, that I had the honor to complete the heroic labor of a large group of scientists, designers, and workers.

In space flight, like in the focus of enormous lens, are concentrated all the latest achievements of science and technique. Our heroes pilots-cosmonauts Yurii Gagarin, German Titov, Andriyan Nikolaev, Pavel Popovich and Valerii Bykovskii have already proved, that to our Soviet people the problems of the space mastering is quite within their power. I wished very much to prove, that we also, the Soviet women can contribute, to the cause of direct space research by the flight on spaceship "Vostok-6".

The unforgetable day of the 16th of June, 1963. The preparations are going on for takeoff. All the work is efficient, by schedule. Next to me are men and women, my friends. They continuously talk of the flight of Valerii Bykovskii. I am slightly worried, but after stepping into space cabin there was no place for worry. Efficiently and consecutively I check the equipment, maintain continuous communication. From the tone of conversation I feel, that everything is in order. Finally takeoff, I tried to note down everything and to fix my sensations, my feeling, observations.

After the insertion of the spaceship into orbit, I begun implementing the flight assignment. The flight of "Vostok-6" continued for 71 hours, during this time I orbited the earth 48 times. The total extent of the space path was about 2 million km.

The flight assignment included various types of jobs with the cabin's equipment, with life support systems, radio-communication. All the observations I entered into the log book, on tape-recorder, filmed with cine-camera. Besides work time was provided also for rest. The weightlessness I stood well. Got quickly used to it. True, it was some what unusual to sleep with arms in suspended position, Thereafter, remembering experience of German Titov, I pushed my hands under the harness during sleep. Otherwise my sleep was sound, without dreams.

After the rest, according to time-table was the time, for physical exercises and breakfast. Physical exercises I did with pleasure. My meals were of good products. I ate with appetite. The menu was quite diverse, but at the end of the flight I felt a wish for black bread, potatoes and onions. All by the way, Soviet people, who met me at landing, with great pleasure fed me with those "delicacies".

I am being frequently asked, how I could get ready for such an uncommon, unwomanly task, as the control of spaceship in flight.

Some people reason, that there is nothing difficult in this, the ship's automatics operate on their own and the role of woman-cosmonaut is insignificant. We were not satisfied with this role. We understood our task in active operation control of all the ship's systems and primarily of manual control and life support systems.

I and my girl-friends have firmly decided to get ready really, in full scale. There was only one conclusion. To learn and work persistently, to undergo various daily training.

Everybody knows, that the first cosmonauts, both in our country and abroad, are the pilots. This is not incidental: pilots in their work acquire qualities, required by the cosmonauts. Therefore, during our training we flew on transport planes and were acquiring the experience of operating large number of devices, learned to correctly distribute and changeover our attention.

A large part of our training were the flights for weightlessness. Here, though briefly, we were getting into conditions prevailing on spaceships.

Of very great benefit to us were the jumps with parachutes. We already had a substantial experience in parachute jumping.

But during the training we jump again and again in different conditions. This enabled us to acquire a lot of the necessary experience, and also made us morally ready to implement difficult space flights.

Is it all so easy? Of course not. But we were not afraid of difficulties. And the grandiose target gave us new strength.

Preparation and implementation of a new flight require coordinated work and effort of specialists in most diverse spheres.

In this connection I would like to mention one detail. When one meets directly these clever, talented people, who create the space technique, one is amazed at the amount of talents in our Soviet people, and it is strange to realise the dry newspaper phrase, that in the Soviet Union the output of engineers and technicians is higher than in any other country.

These people were always ready to teach, explain, to render help to me and my girl-friend.

Our instructors, without sparing time or effort, taught and trained us. With people like this any task is possible. Very persistently we studied the spaceship. Initially a dumb admiration of the technique, then detailed dismantling of all the systems and then practical mastering and intensive training in the control and use of the ship.

We have passed many hours in the training device, but this gave me confidence during the flight. According to assignment I had to orient the ship by means of manual control. I started the manual control, noted and recorded the initial pressure in cylinders, started stopwatch. The attitude of earth through the portholes was such, that it was expedient to begin the orientation by pitch axis. Having oriented the ship by the pitch, I quickly oriented it by the bank and Yaw. I shut the stopwatch, read and recorded indications of devices.

I was glad to see, that I used little time and fuel. The spaceship was obedient and easily controlled. Besides this orientation "in landing way", I had oriented the ship also "in the flying way".

A large part in the flight assignment was taken up by radio-communication. A lot has already been said of the significance of communication in space flight.

I would like to mention one fact. When I conversed with Valerii on short-wave channel, I had the impression, that we were sitting in one room back to back and talk. A real effect of the presence!

The whole flight was full of unforgettable impressions. Frequent sunrises and sunsets, quick change in the nature of locality being passed, continents, oceans, mountains, clouds, rivers, towns, fields.

On the third day a command was transmitted to me from the earth for descent. It is nice in space, but we must return home. All the systems of the spaceship operated efficiently. From increasing overstrain I understood, that the spaceship was re-entering. Beyond the portholes the flames were ragging.

Finally, landing. Again on dear earth. Gladness - the assignment is implemented, everything in order. And ardent touching meetings with our Soviet people.

Everything that is good in me I owe to our Communist Party, Komsomol.

And as a member of CPSU always ready to carry out any assignment of the Party and the Government.

Thank you for your attention.

"Pravda", 26th June, 1963.

Tass Communique. In Orbit First in the World Three-Seater Spaceship "Voskhod".

In the Soviet Union today, the 12th of October, 1964, at 10 hours 30 minutes Moscow time a new powerful carrier-rocket has placed into earth orbit for the first time in the world a threeseat piloted spaceship "Voskhod". The spaceship carries a crew, consisting of the Soviet Union citizens Komarov Vladimir Mikhailovich commander of the spaceship, Feoktistov Konstantin Petrovich - scientist and Egorov Boris Borisovich - doctor.

The objects of the new space flight are:

- tests of the new multi-seat piloted spaceship;
- the efficiency and interaction investigation in flight of a group of spacemen, made up of specialists in different spheres of science and technique;
- scientific physico-technical investigations in conditions of space flight;
- continued effect study of various space flight factors on human organism;
- extended medico-biological investigations in conditions of a long flight.

These investigations are being carried out by means of equipment carried aboard with direct participation of the scientist and the doctor, composing the crew of the spaceship.

The spaceship satellite "Voskhod" was placed into orbit close to calculated one. According to preliminary data, orbited period of the spaceship is 90.1 min., the perigee and apogee distances 178 and 409 km respectively, orbital inclination about 65°. A two-way radio-communication is being maintained with the spaceship "Voskhod".

According to report of the spaceship's crew comrades Komarov, Feoktistov and Egorov every one in the crew has satisfactorily stood the orbital insertion and transition to weightlessness.

Comrades Komarov, Feoktistov and Egorov feel quite well.

The communications from aboard the spaceship "Voskhod" are transmitted on frequencies 143.625; 17.365; 18.035 megacycles per second.

The spaceship also carries transmitter "Signal", operating on frequency 19.9944 Mcps.

All systems aboard the spaceship function normally.

Further communiques on the flight's progress will be transmitted by all radio stations of the Soviet Union.

"Pravda", 12th October, 1964. (Special issue).

Statement of the Commander of Spaceship "Voskhod" Prior to Takeoff.

Dear friends, comrades!

We are happy, that the Communist Party and the Soviet Government have entrusted to us the continuation of the glorious cause of mastering the space, began by our comrades - cosmonauts of the Soviet Union.

We are specially glad of the fact, that the flight of our spaceship is called to open a new page in space research.

For the first time in the history of mankind a crew of three men is departing for distant space on one spaceship. This even in the space gives a wonderful feeling of unity, imparts to us new strength and greater confidence, that the responsible and noble assignment of our motherland we shall carry out worthily.

We assure the Lenin's Central Committee, Communist Party of Soviet Union, our dear countrymen, our dear and near ones, that we shall apply all our knowledge and skill, all the inherent to Soviet people energy and will to victory, to justify the trust shown to us.

Long live the Union of the Soviet Socialist Republics - birth land of the cosmonautics!

Long live our heroic people!

Till we meet again soon, dear comrades, on our Soviet land!

From Aboard the Spaceship "Voskhod".

Flying above the territory of Africa, the crew of the spaceship transmitted a greeting to the peoples of Africa: "We greet the people of Africa, who struggle for freedom and independence! Spacemen Komarov, Feoktistov, Egorov".

While completing the first revolution around the earth, the spacemen transmitted a greeting to the peoples of the Soviet Union.

To Soviet people - builder of communism, pioneer in the conquering of space - ardent greeting.

Spacemen: Komarov, Feoktistov, Egorov.

Revolution by Revolution.

The first in history multi-seat spaceship "Voskhod", carrying Engineer-Colonel Komarov Vladimir Mikhailovich commander of the ship and members of the crew - Feoktistov Konstantin Petrovich - scientist and Egorov Boris Borisovich - doctor, has completed its first revolution.

When leaving the limits of the Soviet Union on the first revolution the spacemen transmitted to earth: "Feeling well, the assignment shall be implemented".

Doctor-cosmonaut Egorov generally checked the spacemen. They had breakfast. The commander of spacecraft transmitted: "Conditions in cabin normal: pressure 1.1 atm., temperature 18°C, relative humidity 58%."

Spaceship "Voskhod" completed the second revolution. On the second revolution the spacemen continued their work in accordance with program. The spacemen transmitted a greeting to participants of Olympics in Tokyo:

To participants of the eighteenth Olympic games.

"Flying above Tokyo we warmly greet the youth of the world, participating in Olympic games, who are called to play a great role in strengthening cooperation and mutual understanding of sportsmen from every continent, approachement of nations and strengthening the cause of peace".

Spacemen: Komarov, Feoktistov and Egorov.

All systems of the spacecraft operate satisfactorily, conditions in cabin normal. The flight continues.

"Pravda", 12th October, 1964 (Special issue) (TASS).

Pages of Biography.

Vladimir Mikhailovich Komarov was born on the 16th of March, 1927 in Moscow. He is a member of the CPSU since 1952.

Even in childhood Komarov began to dream of aviation. In 1942 he entered the First Moscow Special Air Fore School, which he finished in 1945 with excellent marks. The same year Vladmir Mikhailovich enters the Bataiskii Air-Force School of pilots, which he finished in 1949 and served as pilot in the Air Force.

The command speaks well about Vladimir Mikhailovich, mentioning, that the flies daringly, confidently, in difficult conditions does not lose his presence of mind, takes quick and sensible decisions. He has the rank of"Air-Force Pilot 3rd Class".

In 1954 Komarov became a student at Zhukovskii Air-Force Engineering Academy. The higher course of military engineering he finished in 1959.

The pilot-engineer Vladimir Mikhailovich Komarov has successfully completed the special training. Has studied to perfection the equipment of the spaceship. He is a good parachute jumper, has to his credit 77 parachute jumps. In 1960 he got the rank of "Instructor of air-borne troops".

For his good service in the Soviet Army V.M. Komarov was awarded Order of Red Star, medals "For Combat Service", "XXX years of Soviet Army and Fleet", "40 years of Armed Forces USSR", "For faultless service". Col. Eng. Komarov is now a post-graduate of Zhukovskii Air-Force Engineering Academy.

Vladimir Mikhailovich is married. His wife Valentina

Yakovlevna is a graduate of History-physiological faculty of Grosny Pedagogical Institute. At present works as librarian. They have two children: son Evgenii, born in 1951 and daughter Irina, born in 1958.

Konstantin Petrovich Feoktistov was born in 1926 in Voronezh. He is a non-Party man.

He is a participant in World War II. At the age of 16 he was a military scout. In 1942 he was wounded. After this Feoktistov finishes the ten-year school and in 1943 joins the Bauman Moscow higher technical school, which he finished in 1949.

Working in various research departments, K.P. Feoktistov recommended himself as a specialist in technical problems.

In 1955 he was awarded a diploma of candidate of technical sciences.

For achievements in the development of Soviet science and technique Konstantin Petrovich Feoktistov was awarded two orders of the "Red Labour Banner".

For participation in the Great Patriotic war he was awarded medal "For victory over Germany".

The special training K.P. Feoktistov completed successfully.

As a member of the crew the scientist is well prepared.

He is married. His wife Galina Nikolaevna works as technician at one of the Moscow industires. Their son Andrei was born in 1962.

Boris Borisovich Egorov was born in 1937 in Moscow.

Having finished middle school, Egorov in 1955 entered the first Moscow medical institute, which he has successfully finished in 1961.

While still in the Institute Boris was keen on science, having chosen aviation and space medicine. After finishing the Institute Boris was working in various medical-research organizations and recommended himself as far from ordinary scientist. Ten scientific works of Egorov were published in special periodic press. For his high working qualities the young scientist was awarded a decoration "Excellent Health Service".

At present the investigator is getting ready to defend a thesis for a candidate.

Medical service lieutenant, Boris Borisovich Egorov has successfully completed the special training. As a member of the crew he is well prepared. He has 11 parachute jumps to his credit. He is a good sportsman - skiing and mountainering.

Egorov is married. His wife Eleonora Valentinovna is a doctor, works as intern in the eye clinic of the first Moscow Medical Institute. Their son Boris was born in 1962.

"Pravda", 12th October, 1964 (Special issue).

Tass Communique. "Voskhod" - In Flight.

The flight of spaceship "Voskhod" successfully continues. On the third and fourth revolution in accordance with flight assignment physiological investigations were carried out. Blood pressure was measured in spacemen, pulmonary ventilation, blood smears were taken. The efficiency was also investigated of the spacemen by specially developed methods. The ground resources continuously control the ship, check the functioning of its equipment and the state of spacemen. All systems of the ship operate normally. A steady two-way communication is maintained with the spacemen. The call signal of the spaceship "Voskhod" is "Ruby".

Flying above Europe and Asia the spacemen have sent greetings to the people of these continents:

"We wish peace and happiness to the people of Europe. Spacemen: Komarov, Feoktistov and Egorov".

"Best wishes to the people of Asia. Spacemen: Komarov, Feoktistov and Egorov".

On the fourth revolution the spacemen had their lunch. Thereafter, in accordance with individual time-table, it was rest for the ship's commander Komarov.

The spaceship "Voskhod" continues its flight.

In accordance with the time-table the crew commander had free time on the fifth revolution for rest and sleep. The crew members during this time conducted scientific observations. Thus, K.F. Feoktistov observed the state of the earth's cloud cover, conducted photometric investigations. The doctor B.B. Egorov implemented physiological observations, specially, of the state of cardio-vascular system and function of vestibular apparatus. The program included blood-pressure determination and functional tests with irritation in doses of vestibular apparatus in Feoktistov and Egorov.

Flying above the Chinese People's Republic, the spacemen transmitted: "Best wishes from aboard the Soviet spaceship "Voskhod to multimillion Chinese people. Spacemen Komarov, Feoktistov, Egorov".

On the fifth revolution, when the spaceship "Voskhod" was above Australia, the spacemen transmitted greeting to Australian people: "Best wishes to Australian people. Spacemen Komarov, Feoktistov, Egorov".

On the sixth revolution the ship's commander executed manual orientation from stars. At the same time Feoktistov determined the position of the spaceship with the use of astro-orientation. The experiment was successful. Doctor Egorov was resting on the sixth revolution.

The ground command and measuring center steadily receives measurements, telemetric and TV information. The processing of received data shows, that all systems of the spaceship operate normally. Temperature in the cabin 19°C, humidity 50%, pressure 780 mm of mercury. The spacemen feel fit.

On the sixth revolution the spacemen have expressed their gratitude to Soviet scientists: "To Soviet scientists, engineers, technicians and workers. Many thanks for creating a wonderful spaceship "Voskhod". Spacemen Komarov, Feoktistov, Egorov".

While flying above the South-American continent, the spacemen greeted the people of Latin America: "Greetings to the people of South America, best wishes for peace and prosperity. Sincere greetings to heroic people of revolutionary Cuba. Spacemen Komarov, Feoktistov and Egorov".

The multi-seater spaceship "Voskhod" has completed eight revolution around the earth. From 9th to 13th revolution the spaceship wont be flying above the territory of the Soviet Union. In spite of it being late, the working program of the spacemen remains strenuous. They will continue physico-technical and medico-biological investigations and observe the performance of the ship's equipment. They will take rest turn by turn. During this period the Coordination center will regularly be receiving telemetric information on physiological indices of the spacemen and main parameters of the spaceship "Voskhod". On the 7th revolution the ship's commander and the scientist continued observations. The tests were conducted of the manual orientation system. At the end of the 7th revolution the spacemen dined.

Flying above the territory of North America, the spacemen greeted the people of USA: " Best wishes from aboard of spaceship "Voskhod" to industrious American people. We wish peace and happiness to the people of United States of America. Spacemen Komarov, Feoktistov, Egorov".

The first day's flight program was fully completed. The spacemen feel well. Hygienic conditions in the cabin are normal. All the systems aboard and the ground control center operate unfailingly.

The coordination center carries on continuous processing of trajectory and telemetric information, incoming from various measuring centers throughout the Soviet Union.

"Pravda", 15th October, 1964.

Tass Communique "Voskhod" Continues its Flight.

At night, when the spaceship was not passing above the territory of the Soviet Union, the spacemen continued scientific observations. Doctor B.B. Egorov transmitted to earth, that the spacemen are feeling well. On the 13th of October at 4 hours 28 minutes on the 13th revolution the spaceship again appeared above the Soviet Union territory.

All the systems of the spaceship operate unfailingly. Hygienic conditions in the cabin are normal: pressure 1.15 atm., temperature 22°, humidity 47%. The ground command control center continuously observes the ship.

On the 14th revolution of the spaceship "Voskhod" the command control centers in the eastern parts of our country conducted several sessions of radio-communication with the ship. The current orbital parameters were verified, a large volume of telemetric information was received, a number of additional technical tasks were transmitted aboard the spaceship, which the crew must carry out with the object of training and getting practical experience in controlling the ship and its systems. The crew of the spaceship transmitted to earth reading of the main instruments in the control and life support systems. All parameters are within the normal limits. V.M. Komarov and K.P. Feoktistov have completed their rest, they continue implementation of the prescribed investigations program. B.B. Egorov took his rest after the morning breakfast. On question from earth the spacemen answered: "Had breakfast with appetite and pleasure. Feel wonderful. Everything is in order on board".

On the 14th revolution, flying above Japan, the spacemen transmitted greetings to the Olympic team of the Soviet Union:

"To comrade Mashin Yurii Dmitrievich!

The Olympic pennant received, we carry it above all earth, will try after landing to send it to you in Tokyo. We wish great success to all the participants of the Olympic games, and to our team - victory and return with medals. Until we meet. Spacemen Komarov, Feoktistov and Egorov".

Spaceship "Voskhod" completed fifteenth revolution around the earth. As before the flight progresses normally. Every member of the crew carries out the assigned duty. The spaceship's commander Komarov is keeping an eye on the performance of the spaceship's equipment, tests control and orientation systems. The scientist Feoktistov photographed horizon on the 15th revolution, determined efficiency from the proof-sheet. Doctor Egorov rested.

Before the start of the 16th revolution the crew of the spaceship had their second breakfast.

The communique from aboard the spaceship says, that all the spacemen feel fit. Pressure, temperature and humidity in the cabin are within the normal limits, all the systems aboard operate unfailingly. The command control center continues observations of the spaceship's flight and reception of telemetric information.

"Pravda", 14th October, 1964.

Tass Communique Triumps of Soviet Science and Technique.

Today, the 13th of October, at 10 hours 47 minutes Moscow time the new three-seater spaceship "Voskhod", piloted by Col. Eng. Komarov and members of crew scientist Feoktistov and doctor Egorov, having successfully completed the assigned program of research, has safely landed in the marked area.

All the crew members of spaceship "Voskhod" feel well. On landing comrades Komarov, Feoktistov and Egorov were met by sport comissars, correspondents and friends.

The research program, estimated for 24 hours of the flight, fully completed. Valuable data were obtained on the flight of a group of spacemen, made up of different specialists. For the first time the scientists were conducting direct space research.

The material, obtained as a result of the flight, is being processed.

"Pravda", 14th October, 1964.

<u>To Communist Party and People of the Soviet Union! To People and Governments of all Countries! To all Progressive Mankind!</u>

<u>Address of the Central Committee of CSPU, Presidium of the Supreme Council of U.S.S.R. and of the Government of the Soviet Union.</u>

Dear comrades, friends!

We inform you with great joy of the new feat of Soviet people in the mastering of space. For the first time in the world a space flight was accomplished of a multi-seater Soviet spaceship "Voskhod" with a crew on board.

The courageous and all-round prepared spacemen commander of the ship comrade Komarov Vladimir Mikhailovich, scientist, candidate of technical sciences comrade Feoktistov Konstantin Petrovich, Doctor comrade Egorov Boris Borisovich accomplished a space flight on the new spaceship "Voskhod" and safely landed on the native land, in prescribed area of the Soviet Union.

The spaceship satellite "Voskhod" was placed into orbit on the 12th of October, 1964 and during the 24-hours in space It orbited the Globe 16 times, covering a distance of about 700 thousand km. The equipment and the instruments of the spaceship operated unfailingly throughout the flight, assuring to spacemen the necessary conditions of controlling the ship, conduct scientific research and return to earth.

The unparalleled space flight of a multi-seater spaceship with a crew on board became possible due to construction of more powerful and perfect rockets, one of which was used to direct into the immense space distances the new Soviet ambassador of mankind spaceship "Voskhod".

Having completed with exceptional success the historic voyage, the heroic crew of Soviet spacemen Komarov, Feoktistov and Egorov has opened a new stage in the mastering of space. For the first time a space flight was accomplished on one spacecraft of a group, capable for a long time simultaneously with the control of ship to conduct research in the sphere of cosmonautics, biology and other sciences. This flight has again demonstrated the high quality and perfection of the Soviet space technique: powerful carrier-rockets, complex spaceships satellites and of the whole equipment, required for a main-in-space flight. Now once more it is proved in deed, that to wonderful Soviet scientists, designers, engineers, technicians, our glorious working class there is no difficulty in resolving the most complex problems in the mastering of the space mysteries. Investigations, conducted during the flight, have given new priceless contribution to science and are firm scientific foundation for prolonged space journeys of a group of spacemen.

The new great victory in the subjugation of space raises even higher the fame of our socialist Motherland. It clearly demonstrates to the whole world the unprecedented feats of which are capable the Soviet people, freed from the class and national oppression, what gigantic power and talents have raised in them the revolutionary energy.

The Communist Party of the Soviet Union have raised a galaxy of valieant spacemen, Soviet heroes, ready at the call of the Party and Government to carry out any assignment and who have shown selfless heroism and courage in the struggle for subjugation of outer space.

Yurii Gagarin, Herman Titov, Andriyan Nikolaev, Pavel Popovich, Valerii Bykovskii, Valentina Tershkova, Vladimir Komarov, Konstantin Feoktistov and Boris Egorov - their names are known in every country, all honest people on earth are proud of their feats.

The successfully completed flight of the spaceship satellite "Voskhod" lights up a new the outstanding achievements of the Soviet people in the development of science and technique, in the raise of the national economy, in the building of communism. Every Soviet victory in space is a convincing proof, that the Soviet science is in advance of the world's scientific thinking. In these victories, like in a focus, the advantages are reflected of the socialist order, the successes in economic competition with capitalism, the creative genius of the Soviet people,, correctness of the Communist Party politics, the triumps of Marx and Lenin's ideas.

With a feeling of joy, ardent Soviet patriotism are filled in these days the hearts of Soviet people. Communist Party, the whole Soviet people admire the heroism of their countrymen, new spacemen Komarov, Fecktistov, Egorov, who brilliantly carried out the assignment of motherland and multiplied its fame. The Party and people are proud of the selfless labor of scientists, designers, engineers, technicians, laborers, all those, who participated in construction of the new spaceship satellite "Voskhod" and made possible its successful flight.

The conquest of the space is developing at exceptionally high rate. Research stations, created by mind and creative labor of a man, are observing the moon, lay routes to the planets of our system, radio-telescopes investigate the depths of the universe, which from an object of theoretical investigations becomes an object of scientific experiments. The science and practice uncover more and more completely the picture of the universe, its development processes.

It is difficult to overestimate the contribution made during the last few years to research and mastering of space by the Soviet Union. Our scientists, designers, workers, heroic spacemen are carrying on this noble work with exceptional enthusiasm, clearly realising, that they are doing this in the name of the mankind's progress, for strengthening the peace throughout the world. The Soviet Union consistently follows Lenin's policy of peace on earth, it stands resolutely for the use of space only with peaceful aims, so that it may become the field of the most extensive research for the good of mankind, but not a base of nuclear weapons.

The Soviet people is building a communist society, to which the aggressor wars and enslavement of nations are alien. Communism brings to the workers of all the countries peace, labor, freedom, equality, brotherhood and happiness of all people. The Soviet Government persistently struggles for general and total disarmament, for resolution of all the controversies between states only by peaceful means.

On this great day we once again appeal to Governments and peoples of all the countries to stop the race for armament, to insist on general and total disarmament, to restrain the "mad" and "half-mad", who are trying to involve the humanity in thermo-nuclear catastrophe, to put out the fires of war, ignited by imperialists. All, to whom the cause of peace is dear, should trebble their efforts in the struggle for retaining and strengthening it.

The Soviet Union is fulfilling its international duty to the workers of other countries by its selfeless labor in the building of communism. It tirelessly multiplies the might of our motherland - stronghold of peace, democracy and socialism. The workers of the Soviet Union successfully carry out the program of the seven-year plan. The collective farming attains new higher levels in the intensification of farming production. The agriculturists have gladenned our hearts by a high harvest of grain and industrial crops. The Soviet intelligentsia in factories and fields, in educational and health departments, in research institutes, in Government bodies - everywhere actively participates in the resolution of problems for constructing material and technical base of communism and communistic education of Soviet people.

The people of the Soviet Union are enraptured by the unprecedented flight of the spaceship satellite "Voskhod".

They respond to the feat of comrades Komarov, Feoktistov and Egorov by new achievements in labor, in the great cause of communism building.

Long live the Union of the Soviet Socialist Republics - birth land of cosmonautics!

Long live the Soviet people - builder of communis, fighter for peace and happiness of the workers of all countries!

Glory to valiant Soviet cosmonauts!

Let the cooperation of all countries in peaceful conquest of space develop and strengthen:

Central Committee of CPSU	Presidium of the Supreme Council of USSR	Council of Ministers of USSR

Forward, to the Victory of Communism!

To scientists and designers, engineers, technicians and workers, all groups and organizations, particpating in the accomplishment of the flight of the crew of spacemen on multiseater spaceship satellite "Voskhod".

To Soviet spacemen Komarov, Feoktistov and Egorov.

Dear comrades!

The Soviet Union has taken up new position in the mastering of the outer space. The new powerful Soviet rocket has placed into orbit a multi-seater spaceship satellite "Voskhod" with a crew of three on board. Equipped in accordance to the latest technique, the spaceship "Voskhod" has completed during the 24 hours 16 revolutions around the earth and safely landed in an area, prescribed by the flight program.

Therewith opens a new stage in the mastering of space, in the research of the immensity of universe.

With the feeling of great joy and pride for its socialist motherland the news was received by the Soviet people, that the conquerors of space were again Soviet people - comrades Komarov Vladimir Mikhailovich, Feoktistov Konstantin Petrovich and Egorov Boris Borisovich.

It is difficult to overestimate the contribution to world science and culture of the heroic crew of spaceship "Voskhod". The commander pilot-cosmonaut Komarov, candidate of technical sciences Feoktistov and Doctor Egorov implemented a composite and many-sided program of research, which is of exceptionally significant value for further long flights of the spaceship's crews.

As a result of this historic flight scientists in various have the possibility now to conduct jointly space research. This collective scientific work, conducted for the first time in the history of mankind in space, was by Soviet group, raised by the Communist Party, united by the immortal ideas of Marx and Lenin.

We warmly congratulate you, dear comrades Komarov, Feoktistov and Egorov, with successful completion of a joint flight on the multi-seater spaceship "Voskhod". You have honourably implemented the assignment of motherland, have written a new page in the chronicle of her fame, opened out new horizons in science.

We note with great satisfaction, that the spaceship satellite "Voskhod", constructed by Soviet scientists, designers, engineers, technicians and workers, is even more perfect than the previous ones and has shown its excellent qualities in a difficult flight. During the whole flight the conditions were retained in the cabin necessary for the work and life of the spacemen; the whole equipment operated unfailingly.

The space flight of a whole crew on a perfect multi-seater spacecraft has shown once more exceptionally clearly the peaks attained by our socialistic economy, science and technique, what undeniable advantages has socialist order over the capitalism, what limitless possibilities have Soviet people, freed for ever from the yoke of capitalism. This feat reflects, as in the mirror, the greatness of our motherland, which is foremost in the social and technological progress of the whole mankind.

The Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council USSR and the Council of Ministers USSR sincerely congratulate scientists, designers, engineers, technicians, workers, medicos - all comrades, who participated in construction of the powerful rocket and multi-seater spaceship "Voskhod", in preparing and implementing the space flight of the Soviet spacemen crew.

Glory to the Soviet scientists, designers, engineers, technicians and workers - creators of perfect space rockets and ships!

Glory to heroic crew of Soviet spacemen!

Long live Lenin's Communist Party of the Soviet Union - inspirer and organizer of all the victories of the Soviet people!

Forward, to new, even greater accomplishments in the name of the triumps of communism!

Central Committee	Presidium of the	Council of
of CPSU	[illegible]	Ministers of
	[illegible]	USSR.

"Pravda", 14th October, 1964.

Decree of the Presidium of the Supreme Council of USSR on Confering the Rank of Hero of the Soviet Union on Pilot Cosmonaut Komarov V.M.

For accomplishment of space flight on multiseater spaceship satellite "Voskhod" to confer the rank of the hero of the Soviet Union with award of the order of Lenin and medal "Gold Star" on pilot cosmonaut comrade Komarov Vladimir Mikhailovich.

A. Mikoyan,

Chairman of Presidium of the

Supreme Council, USSR.

M. Georgadze,

Secretary Presidium of the Supreme

Council, USSR.

Moscow, Kremlin, 19th October, 1964.

Decree of the Presidium of the Supreme Council of USSR on Confering Hero of the Soviet Union Rank on Pilot Cosmonaut Candidate of Technical Sciences Comrade Feoktistov K.P.

For the accomplishment of space flight on multi-seater satellite "Voskhod" to confer the rank of the hero of the Soviet Union with award of the order of Lenin and "Gold Star" medal on pilot cosmonaut candidate of technical sciences comrade Feoktistov Konstantin Petrovich.

A. Mikoyan

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[illegible] of [illegible].

M. Georgadze

Secretary Presidium of the

Supreme Council of USSR.

Moscow, Kremlin, 19th October, 1964.

Decree of the Presidium of Supreme Council of USSR on Confering the Rank of the Hero of the Soviet Union on Pilot Cosmonaut Doctor Comrade Egorov B.B.

For the accomplishment of space flight on multi-seater spaceship satellite "Voskhod" to confer the rank of the hero of the Soviet Union with award of the Order of Lenin and "Gold Star" medal on pilot cosmonaut Doctor comrade Egorov Boris Borisovich.

A. Mikoyan,

Chairman Presidium of the Supreme

Council of USSR.

M. Georgadze,

Secretary Presidium of the Supreme

Council of USSR.

Moscow, Kremlin, 19th October, 1964.

Decree of the Presidium of Supreme Council of USSR on Confering the Rank "Pilot Cosmonaut of USSR" on Comrade Komarov V.M.

For accomplishing space flight on multi-seater spaceship satellite "Voskhod" to confer the rank of "Pilot Cosmonaut of

USSR" on the citizen of Soviet Union comrade Komarov V.M.

A. Mikoyan,

Chairman Presidium of the Supreme

Council of USSR.

M. Georgadze,

Secretary Presidium of the Supreme

Council of USSR.

Moscow, Kremlin, 19th October, 1964.

Decree of the Presidium of the Supreme Council of USSR on Conferring the Rank "Pilot Cosmonaut of USSR" on Comrade Feoktistov K.P.

For accomplishing space flight on multi-seater spaceship satellite "Voskhod" to confer the rank "Pilot Cosmonaut of USSR" on citizen of the Soviet Union comrade Feoktistov K.P.

A. Mikoyan,

Chairman Presidium of the Supreme

Council of USSR.

M. Georgadze,

Secretary Presidium of the Supreme

Council of USSR.

Moscow, Kremlin, 19th October, 1964.

Decree of the Presidium of the Supreme Council of USSR on Conferring the Rank "Pilot Cosmonaut of USSR" on Comrade [illegible]

For accomplishing space flight on multi-seater spaceship satellite "Voskhod" to confer the rank "Pilot Cosmonaut of USSR" on the citizen of Soviet Union comrade Egorov B.B.

A. Mikoyan,
Chairman Presidium of the Supreme
Council of USSR.
M. Georgadze,
Secretary, Presidium of the
Supreme Council of USSR.

Moscow, Kremlin. 19th October, 1964.

"Pravda", 20th October, 1964.

<u>Press-Conference on the Flight of Spaceship "Voskhod".</u>

Yesterday in the Assembly Hall of the Moscow State University a press-conference was held on the first in the world space flight on the multi-seater spaceship "Voskhod" of Pilot cosmonaut Flt. Eng. V.M. Komarov, scientist candidate of technical sciences Feoktistov and Doctor-cosmonaut Egorov B.B.

The Soviet and foreign correspondents and members of the diplomatic corps, assembled in the Hall, have greeted with ovation the heroes of a new space trip, as well as all the other Soviet cosmonauts, scientist and engineers, cheering jointly with the first space crew the laurels of the new victory.

The press-conference was inaugurated by M.V. Keldysh, President of the Academy of Sciences USSR, who spoke of the main results of the new space journey.

New Stage in the Mastering of Space. Address of V.M. Keldysh.

Dear comrades, ladies and gentlemen!

Less than ten years have passed since the launching in the Soviet Union of the first in the world artificial earth satellite, which has initiated the space era.

Space research is based on development of many spheres in science and technique, on the foremost industry of our country, specially in resolving such important problems of the cosmonautics, as the flights of distant multi-seater spaceships.

Soviet scientists and designers, since 1960, began systematic preparation of manned space flights. The most difficult problems were the construction of spaceship, assuring safety of its flight, return to earth. All this required resolving an enormous amount of scientific and technical problems.

Soviet scientists and engineers had to resolve for the first time such problems as the [illegible] of the spaceship in [illegible], [illegible] the retention of the [illegible] orientation systems, heat, protection of the vehicle during its descent to earth. Specially difficult was the problem of the spaceship's return to earth. Out of the numerous schemes of landing the most optimum was taken to be the ballistic re-entry. It was necessary to operate and check in actual conditions all the stages of the ship's return to earth, beginning with the start in space conditions of the braking motor, checking performance of command devices for the start of braking motor at exactly set time and ending with checking of the selected shape of the spaceship, its heat protection during re-entry into the dense atomspheric layers.

Besides the working out of purely constructive elements of the spaceship a great amount had to be resolved of scientific problems, the major ones being medico-biological research and the study of radiation conditions at flight altitudes of future spaceships.

All the spaceships "Vostok" were flying along orbits, ensuring the return of the spaceship to earth by the aerodynamic resistance of the spaceship in the earth's atmosphere. Therefore, it was extremely important to know the density of atmosphere at altitudes 200-400 km, in order to estimate beforehand, when the ship should return to earth, if the braking motor does not operate. Naturally, all the life support systems were constructed with an estimate of the eventuality.

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[illegible]

piloted by the ship's commander Flt. Eng. Vladimir Mikhailovich Komarov and members of the crew candidate of technical sciences Konstantin Petrovich Feoktistov and Doctor cosmonaut Boris Borisovich Egorov.

The spaceship "Voskhod" is considerably different from the series of spaceship-satellites "Vostok".

For the first time the spacemen were without space suits and without the ejection system. For this it was necessary to provide primarily for the tightness of the ship, as the slightest breach in the air-tightness would have resulted in the death of the crew. Landing of the spaceship required reliable performance of all the systems at the moment of landing. The possibility was also provided for landing on water and all the necessary measures were taken for its buoyancy and stability on water.

To ensure reliable descent of the spaceship from orbit a second reserve braking motor was carried on board.

The first in the world collective flight of cosmonauts on the spaceship "Voskhod" opens out a new page in the history of cosmonautics. The significance of this flight is extremely high. For the first time a scientist and doctor could personally conduct observations and scientific determinations directly aboard a spaceship.

impossible without the participation of spacemen-scientists.

The first flight of the multi-seater spaceship "Voskhod" was planned for one day, but the general working resources of the ship's equipment are considerably greater. During the flight V.M. Komarov, K.P. Feoktistov and B.B. Egorov has successfully completed the whole flight program. The general control of spaceship was placed on the commander of the crew pilot-cosmonaut Komarov, who implemented with credit the task, assigned to him. The observations are very interesting of K.P. Feoktistov, specially in the optics of the upper atmospheric layers and northern lights. Doctor-cosmonaut Egorov has obtained important data on the state, feeling and various reactions of the crew members during the flight, He conducted a number of tests on movements coordination with weightlessness, took blood in the spacemen and implemented a number of other investigations, which will be a priceless contribution to further development of space medicine. The cosmonauts will tell you all about it today.

On the 13th of October, 1964 at 10 hours 47 minutes the multi-seater spaceship "Voskhod" landed on earth. The spaceship after landing was in excellent condition, and how the spacemen feel we can see for our selves: they are alive, healthy and are present here, rewarded for their heroic flight by the high rank of heroes of the Soviet Union.

Their brilliant flight is a new stage in the mastering of space, [illegible] our people, our science and technics. This [illegible] demonstration of the stormy progress of our country, giving all its forces to the cause of peace, for the good of all mankind.

Dear Vladimir Mikhailovich, Konstantin Petrovich, Boris Borisovich!

Permit me on behalf of the Presidium of the Academy of Sciences USSR to congratulate you on the completion of your flight on spaceship "Voskhod".

To mark your wonderful feat in the name of science the Presidium of the Academy of Sciences, USSR has decreed to award you the K.E. Tsiolkovskii gold medals. Permit me to felicitate you and hand you the gold medals.

<u>For the good of all Mankind.</u>

<u>Address of V.M. Komarov.</u>

Comrades! Ladies and Gentlemen!

On the 12th of October, 1964 in the Soviet Union a powerful new carrier-rocket placed into earth-satellite orbit for the first time in the world a three-seater piloted spaceship "Voskhod".

As you know from our press, the spaceship was blasted off at 10 hours 30 minutes Moscow time and was placed into orbit

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close to calculated one.

Orbital period was 90.1 minute perigee distance was 178 km, apogee distance 409 km, orbital inclination - about 65°.

The spaceship "Voskhod" orbited the earth 16 times and after completing the assigned program has safely landed on the 13th of October, 1964 at 10 hours 47 minute in prescribed area.

The new spaceship is more perfect, than all the previous piloted vehicles, on which ascended into space our comrades Yurii Gagarin, Herman Titov, Andriyan Nikolaev, Pavel Popovich, Valerii Bykovskii and Valentina Nikolaeva-Tereshkova. Our spaceship satellite "Voskhod" has shown its excellent qualities in difficult space conditions.

The program of preparation for the flight was very extensive and composite. For its complete understanding and accomplishment streneous work was required of all the candidates, selected for this flight. We are grateful to all the specialists, instructors, who were preparing us to cope with the set of problems. The success of our flight owes a lot to them.

The program of research was estimated for one day, and the crew has fully implemented it.

The problems, which we were to resolve in this space flight, required participation of all the members of the crew. One man could not resolve, no matter how well he may be prepared. This demanded, in turn, not only similar understanding of the questions of research by all the members of the crew and their appropriate training, but also coordination in work, catching the meaning of each other at once and even interchangeability.

Our crew in space was not big, but indeed a friendly Soviet collective, proud from realization, that we are doing our work for peaceful purpose, for the good of all mankind.

All the members of the crew creatively helped each other in the interesting and composite work, provided by the program of our flight.

Of course, all this did not come at once. Before getting into the cabin of the spaceship "Voskhod", its crew had to long and persistently work, learn and train.

The preparation program of the crew members included various sections of scientific theoretical and professional training of the cosmonauts, as well as the special and physical training. Each one of us had several flights for weightlessness. During the training on stands and special training devices the problems were worked out not only of each cosmonaut specialist, but also details of the interaction of the crew members in flight. In conclusion a comprehensive training was conducted on a training spaceship in accordance with the program of forthcoming flight in actual time scale.

What are the differences and advantages in the flight of spaceship "Voskhod" in comparison to flights of spaceships "Vostok"?

It is well known, that all the six spaceships "Vostok" were single-seaters. Accordingly the cosmonauts were faced with quite definite tasks, estimated for their being carried out by a single person. Whereas the crew of the spaceship "Voskhod" consisted of three men, specialists in different spheres. This enabled not only to expand the sphere of research and experiments, but also to set them on a higher scientific level. If during the flight of the spaceships "Vostok" the spacemen had to periodically stop all his work and to spend a part of the time for sleep in conformity to physiological needs of the human organism, on spaceship "Voskhod" two members of the crew were constantly working, while the third one was resting. Therefore, the work in space never ceased for a minute, and the volume of scientific information has considerably increased. Moreover, the conditions for work and rest assured maximum efficiency of all the members of the crew. If on the spaceship "Vostok" the spaceman, observing one or another phenomenon interpreted it in his own way, on "Voskhod" with observation of similar phenomena there was an immediate exchange of opinions, which assisted in its more objective estimation.

Thus it was, for instance, in the case of observing luminous particles through the port-holes.

It is well known, that the flights on spaceships "Vostok" were in space suits and, as a rule, envisaged landing with parachute outside the ship.

We were the first to fly without space suits, which provided much better conditions for work, made it more convenient. This became possible due to extremely reliable construction of the spaceship "Voskhod", created by the capable hands of our workers, technicians, engineers and designers.

Both on earth and in flight we never doubted for a minute the reliability of our Soviet space technique.

Througnout the flight the cabin retained normal temperature, the necessary air composition and pressure, there was normal communication and good lighting, which could be controlled.

The soft landing system of the spaceship worked excellently. This kind of landing of a multi-seater spaceship with a crew on board has its own advantages and fully justifies itself.

The flight of the multi-seater spaceship "Voskhod" is completed.

And we, who accomplished it, would like here, at the press-conference, to say to the press representatives from all over the world about our pride in and gratitude to creators of the new powerful carrier-rocket and wonderful spaceship "Voskhod", our scientists, designers, workers, technicians and engineers - masters of the highest class of precision. Thank you, friends!

The construction of the new type of spaceship "Voskhod", concentrated, as in focus, reflection of the achievements of our Soviet people, our socialist order, our dear Communist Party.

The first in the world flying space laboratory has completed its many-hours flight.

Our flight is the flight of investigators, whose final object is the mastering of space for the good of all mankind.

There was not a single point in the program of our flight, resolution of which could have been used for war purpose, nothing that aimed against a man, culture, civilization.

And I am proud, that I was carrying out the assignment of Soviet Government, my Communist Party jointly with my friends - the Non-party comrade Feoktistov and a member of the Communist Youth Egorov.

Let there be ascending of tens, thousands peaceful rockets with space investigators, pioneers, blazing new trails into untrodden space world. And let not one rocket ascend for unleashing war.

Our crew feels very fit after our flight. We are ready to implement any assignment in the further mastering of the outer space.

An Important Step in the Development of "Spaceships Building". Address of K.P. Feoktistov.

Dear comrades! Ladies and Gentlemen! Friends!

I had the happiness and honor to participate in the first flight of the multi-seater spaceship "Voskhod" as a scientist. In my opinion, this flight marks the beginning of a new stage in the development of space technique, new stage in space research, since on the multiseater spaceships it is possible to conduct composite physico-technical and medico-biological investigations. Moreover, the presence aboard the ship of several people makes it possible to obtain more objective data.

The spaceship "Voskhod" is a new important step in the development of "space ship building". It is a result of consistent labor of Soviet engineers, scientists, designers, technicians, workers, experimenters and testers. Its construction used the latest achievements of electronics, mechanics, aerodynamics, rocket technique, medicine and other related spheres of science and technique.

The spaceship "Voskhod" differs considerably from the spaceship "Vostok", new threeseater space cabin, new instruments, a number of principally new systems.

For the transfer of ship from the earth satellite orbit to descent trajectory it carried two braking rocket engines: the main one and reserve. This made it possible to change with greater confidence to a higher orbit.

Besides the previously used orientation and control systems, the spaceship "Voskhod" carried a new system for the orientation of the spaceship in orbital flights, which uses ion direction plotters of the ship's velocity vector. This system was successfully tested in flight.

As you know from the newspapers, spaceship "Voskhod" had a soft-landing system, which, it can be said, provided ideal conditions of landing.

A new TV system was used on the spaceship, which assured not only transmission to earth of "reporting" from the space cabin, but also transmission to earth of the picture, observed from aboard the ship. The same TV system was used by the crew to observe the surrounding space from the side of the instrument compartment and braking motor compartment i.e. from the side, where the usual porthole cannot be "cut".

Thus, the system was as though an additional porthole of the cabin.

It must be said, that the past flight has shown high qualities of the spaceship "Voskhod" and the new carrier-rocket.

Throughout the flight: in insertion branch, in orbital flight, in descent and landing, all the systems, equipment, motors and other devices of the carrier-rocket and spaceship, the whole setup of ground centers operated efficiently, reliably, without breaks.

A number of investigations were conducted during the flight.

Observations of horizon were conducted for obtaining data on the clearness of horizon's boundary, for selecting the key layer in the optical range, for navigation and orientation in orbital and interplanetary flights, when the "earth" will have to be used as the "main" clestial body in astronavigational measurements, and for the orientation of spaceships and automatic space vehicles. Now I will speak only of some preliminary results of these investigations, since for the final judgement it is necessary to develop and process the films made of horizon. It is possible, that additional investigations will have to be conducted.

As a rule, on the day-side of the earth the horizon is observed as the boundary of the atmosphere and earth and the "layer" of the pale-blue halo with a clearly-defined upper boundary. The altitude of this layer composes approximately 15 angular minutes. To me the upper boundary of this halo seemed more clear, than the visible boundary between the earth and the atmosphere.

After the entry of the spaceship into the earth's shadow it was possible to observe a layer of brightness 60-100 km above the boundary between the earth and the atmosphere. This layer is clearly visible directly under the moon and the brightness gradually diminishes with removal of observation area from the bearing on the moon. The stars are clearly visible between the layer and the earth surface, although their brightness is considerably less under the layer. The brightness of the layer is similar to that, observed on the horizon of earth surface, illumined by the moon. It is interesting to observe the horizon prior to the ship's exit from the earth's dhadow.

Long before the exit from the shadow it become visible, how the brightness is diminishing of the upper layer (of which I spoke before), there is appearance above the horizon of the pale-blue halo, which gradually gets more pale and without any clearly defined boundary passes into the black color of the space. The height of this halo is several times greater, than on the day side. Gradually it becomes brighter. Finally below on the boundary of earth and atmosphere it becomes reddish; this bottom layer becomes progressively brighter, and suddenly above the horozon appears at first a bright red line, quickly changing into highly extended oval, and then above the horizon appears portion of the solar disc. then the whole disc. and within an instant bright sunlight floods the whole cabin. This is an exceptionally colorful spectacle.

The greatest impression on all of us made the northern light, which we saw in the Antarctic area a few minutes before the exit from the shadow. The picture was of horizon, then dark sky, then the upper layer of brightness, additionally illumined by the moon, above it the rays, perpendicular to horizon, 6-8^{o} in height with intervals of about 2^{o}. Along the horizon the northern light took up the whole visible field of vision.

The observations of the starry sky were conducted with the object of checking the possibility and convenience of orientation by the starry sky with a certain construction of the space cabin and portholes, estimating possibility and convenience of astronavigational measurements by means of sextant.

It was found to be possible to measure altitude of stars above the visible horizon. It means, that in future flights of spaceships, specially in the interplanetary flights, it will be possible conduct independent determinations from aboard the ship of the latter's attitude, to carry out calculations of its flight trajectory and its corrections.

The experiment is interesting on the investigation of the behavior of fluid in conditions of weightlessness.

We were able to observe luminous particles through the portholes of the space cabin. It usually happened, when the direction of observation was perpendicular to solar rays. We all had a clear sensation of nearness of these particles - some meters. It seems to me, that those were dust particles, separated from the ship and illumined by the sun.

A few words about the flight.

When the blast-off of the carrier-rocket is seen from the side, it makes an unusual impression: rumble of rocket engines, blinding flame of their torches, the rocket itself, streaking away into the sky, converting gradually into a bright point, then disappearing into infinity. This is a grand and colorful picture.

However in the space cabin it is perceived somewhat simpler. If we do not speak of the joy, connected with the accomplishment of the flight ("at last I am off"), then everything is even like an every-day affair:

- soft breakaway from the earth,
- the noise is not too loud (comparable to the noise in the cabin of a modern liner),
- vibrations not too severe: low frequencies mainly only in transonic region,
- light swinging of the rocket, resembling swaying of a train on the way,
- easily-endured overstrain.

At the end of each rocket stage they, naturally, increase and correspondingly at the start of a new stage drop almost to the usual level. Generally the propulsion branch is not hard to endure.

As you know, the descent and landing have passed very well. After operation of the braking motor, in accordance with the regular scheme of the flight there was separation of descending vehicle and instrument compartment. For a long time we saw in the portholes the instrument compartment, which was naturally flying next to us after the separation. With re-entry into dense atmospheric layers the illuminance became noticeable in the portholes of the boundary layer. The black sky disappeared, a red-orange shroud could be seen beyond the portholes, only through portholes facing the earth we could see it covered with clouds. Soon even this picture could not be observed - the brightness of the boundary layer was higher. For many of you it is probably no secret, that the gas temperature within boundary layer around the re-entering vehicle is about 10,000°.

The overstrain gradually increased. However, we stood it well.

After the ship's velocity was quinched due to atmospheric braking, at altitude of 5 km with velocity about 220 m/sec the parachute system was activated. The vehicle continued its descent on the parachute system. Right above the earth surface a new landing system was activated, which ensured landing of the vehicle at practically zero velocity.

You, of course, understand, that this flight was a great joy and satisfaction to me. To take part in a space flight is a great honour for any man. I would like to take advantage of the occasion and once more to thank our Communist Party and the Soviet Government for the high trust shown in me.

<u>A Remarkable Stellar Trip.</u>

<u>Address of B.B. Egorov.</u>

Mr. Chairman, dear comrades, Ladies and Gentlemen!

I am glad to have participated in an extremely interesting medico-biological experiment on the spaceship "Voskhod", and are ready to share with you so far only the most preliminary results of the carried out investigations and my direct impressions of the orbital flight on the multi-seater spaceship.

The increment of the crew to three people and introduction into its composition of a doctor have opened out principally new possibilities for studying a number of problems in space biology and medicine.

I am extremely grateful to all, who with their enthusiasm and labor assisted in creation of the space laboratory "Voskhod" and assured this remarkable stellar trip. I thank all my comrades in flight for their help and participation in medico-biological investigations on board the spaceship.

The following were the problems of medico-biological investigations aboard the spaceship "Voskhod":

1. Study of the functional condition of the central nervous system and efficiency of the crew members at various stages of the space flight.

2. Study of the effect of a combination of space flight factors on the functional state of the cardio-vascular and blood systems.

3. Investigation of external respiration, gas-exchange and energy consumption in conditions of weightlessness.

4. Functional state investigations of analyzers in conditions of weightlessness.

5. Effectivity estimate of life support and landing systems.

To implement these tasks remote recording of physiological parameters by means of telemetry was used. Moreover, the doctor cosmonaut had in his hands devices and other means for carrying out direct determinations and investigations.

Recorded by telemetry in each cosmonaut was electrocardiogram in one chest section, respiratory movements of the chest, seismocardiograms (fluctuations of chest, caused by systoles).

Following the earlier prepared program and also due to circumstances I was able to record in my self or in my comrades cerebral biocurrents, electric potentials, arising with voluntary and involuntary movements of eyes, parameters, characterizing coordination of movements in figure-drawing and writing, and also the curve of muscular efficiency in the rhythmic movements of the wrist.

Moreover, the pulse and respiration rate of the cosmonauts were continuously transmitted during the flight by means of short-wave transmitter "Signal" to ground reception centers.

Besides the medico-biological investigations my duties included also (in the case of need) medical aid to the members of the crew and the control of life support systems aboard the spaceship.

So as not to return to this question again, I may as well say, that I did not have to give any medical aid to the cosmonauts, therefore, I did not carry out the duty of the onboard doctor, although it gave me a clear concept of the possibilities at the disposal of a spaceship doctor.

As regards the performance of the life support systems, mention should be made of their high reliability throughout the flight. Hygienic conditions in the cabin were almost optimum. Air pressure corresponded to atmospheric, concentration of oxygen and carbon dioxide was normal, humidity varied from 45 to 60% at temperature 18-21°. Any outside smells were not noticeable in the cabin, the air felt fresh. The artificial ventilation of the cabin enabled the spacemen to remain in the cabin in light woolen suits of sport type.

The food on board, as already given in the press, consisted of various products, packed in rayon.

The taste qualities of the ration both in ground tests and during flight were highly appreciated by all the members of the crew. The appetite of the cosmonauts during the flight was quite normal.

High appreciation deserves also the construction of armchairs modelled to fit the body of the cosmonauts. Inclination of the armchair details provided optimum position of the spacemen in respect of the overstrain vector both during the orbital insertion and during the descent trajectory and landing.

The moment of transition to weightlessness did not cause any unpleasant sensations. We discovered our being in weightlessness mainly from the unusual sight of the objects floating around the cabin. Carefully analysing our sensations, Feoktistov and I found, that with closed eyes there is an illusion of being upside down.

The efficiency of all of us during the flight was high. Subtle coordinated movements were executed without difficulty, handwriting did not show any considerable changes. A more detailed analysis of the motor function will be made after the study of telemetry data, however even now it should be mentioned, that in conditions of weightlessness it is quite possible to carry on work, connected with application of most diverse scientific equipment.

The program of experimental research during the flight was so full, and the time so short that we had to economise in in rest. We slept by turn for 3-5 hours. The sleep was sound, without dreams. After sleep we felt rested, fresh.

The thorough after-flight examination, to which we were subjected on landing, did not detect any disorders in the state of our health.

Some changes were discovered in the morphological picture of blood, in water-salt metabolism, etc. However, these changes had transitory and, apparently, non-specific nature, indicating certain general fatigue and tension reaction, caused by the combined physical and psychological factors of flight.

Physiological parameters, recorded by means of telemetry, are at present being processed, analysis of blood samples taken in flight and of exhaled air are not yet completed. And, naturally, the material as a whole is not as yet processed and analysed, therefore, I would not at present draw any conclusions. When the processing is completed of the whole experimental material a detailed report will be published, which will be of interest to a wide sphere of people, interested in problems of the space flight.

Thank you for your attention.

Thereafter, the spacemen and the President of the

Academy of Sciences, USSR answered numerous questions of the journalists.

"Pravda", 22nd October, 1964.

Tass Communique. "Voskhod-2" in Flight.

On the 18th of March, 1965 at 10 hours Moscow time the Soviet Union placed into earth orbit by means of a powerful carrier-rocket spaceship-satellite "Voskhod-2", piloted by a crew of two - pilot cosmonaut Col. Belyaev Pavel Ivanovich commander of the ship and co-pilot Lt. Col. Leonov Aleksei Arkhipovich.

The spaceship satellite "Voskhod-2" was placed into orbit, almost as calculated.

According to preliminary data the orbital period is 90.9 minutes, perigee and apogee distances 173 and 495 km respectively, orbital inclination about 65°.

Two-way radio communication is being constantly maintained with the spaceship "Voskhod-2".

According to report of the ship's commander comrade Belyaev, and also data of telemetric measurements, the crew has satisfactorily stood orbital insertion of the spaceship and transition into weightlessness.

Comrades Belyaev and Leonov are working in accordance with research program, they feel quite fit.

Communications from aboard the spaceship "Voskhod-2" are transmitted on frequencies 143.625; 17.365 and 18.035 megacycles per second.

The spaceship carries also transmitter "Signal", operating on frequency 19.996 Mcps.

All the systems aboard "Voskhod-2" operate normally.

Further communications on the progress of the flight will be transmitted by all radiostations of the Soviet Union.

Today, 18th of March, 1965 at 11 hours 30 minutes Moscow time during the flight of spaceship "Voskhod-2", a man has stepped for the first time from vehicle into space.

On the second revolution the co-pilot Lt. Col. Leonov in a special space suit with an independent life support system came out into space, moved away from the spaceship for about 5 m, successfully completed of investigations and observations and safely returned to the ship.

By means of the TV system aboard the exit of comrade Leonov into space, his work outside the ship and return were transmitted to earth and watched by a network of ground centers.

Comrade Leonov was feeling quite well during the period outside the spaceship and after his return. The commander of the spaceship comrade Belyaev is also feeling well.

The following will be carried out during the further flight of spaceship "Voskhod-2".

- testing systems of spaceship;
- medico-bilogical investigations in conditions of space flight and other researches.

Pavel Ivanovich Belyaev - commander of the spaceship.

Comrades Belyaev and Leonov are continuing their work in accordance with the program.

All the systems on board the spaceship operate normally.

Further communications on the progress of the flight will be transmitted by all radio stations of the Soviet Union.

The flight of spaceship "Voskhod-2" is successfully continuing. Millions of TV viewers saw on the screen the exit of pilot-cosmonaut Leonov from the vehicle and his free floating in space. While being outside the spaceship, the cosmonaut examined the external surface of the spaceship, cut-in the cinecamera and visually observed the earth and the space. On completing the program cosmonaut Leonov returned to the ship.

Total time of cosmonaut Leonov in the outer space was about 20 min. including 10 min. outside the ship. All the operations of exit and return the spacemen carried out under supervision of the ship's commander, maintaining with him continuous communication.

The commander of the spaceship Col. Belyaev to control center:

- The assignment for exit into the outer space and return to ship is fully completed. The parameters in cabin

medical-control systems. The cosmonauts feel well. Pulse 70-72. Respiration rate 18-20. The prescribed are maintained in the space cabin. Temperature 19°C, pressure 760 mm of mercury. The astronauts had their meal with appetite, thereafter, comrade Leonov in accordance with the program had his rest. The commander of the spaceship Col. Belyaev conducted astronavigational observations and measurements.

Greetings were transmitted from aboard "Voskhod-2" to the people of the Soviet Union, Europe, Asia and Africa.

The successful flight of the spaceship "Voskhod-2" is continuing. At 21 hours Moscow time the spaceship has completed its eighth revolution.

From 8th to 13th revolution the spaceship "Voskhod-2" will not overfly the Soviet Union. The radio-communication will be maintained with it in short-wave band.

During 11 hours of the flight the ground measuring setup received a lot of useful information on the flight trajectory and performance of all the systems of the spaceship. According to the data all the systems function normally.

The program of medico-biological research provided information on physiological characteristics of reactions and nature of movements with free floating in space.

From aboard the spaceship cosmonauts transmitted to Soviet scientists, designers, engineers, technicians and workers gratitude for the construction of spaceship "Voskhod-2". While flying above Southern and Northern America, the spacemen transmitted greetings to the people of Cuba, Latin America and USA.

Hence the crew shall carry out the program of research, taking rest by turns. On the 19th of March, at 4 hours 14 minutes Moscow time the spaceship satellite "Voskhod-2" on its 13th revolution will again appear above the territory of the Soviet Union, in Far East.

Statement of the Commander of the Spaceship "Voskhod-2" Prior to Takeoff into Space in the Name of the Crew.

Our dear friends! Comrades!

It is difficult to describe the feeling of the great happiness, which we experience from the thought, that we, two Soviet citizens were entrusted by the Communist Party and the Soviet Government to carry out a new assignment in the mastering of the space, began by our comrades, cosmonauts of the Soviet Union.

The forthcoming flight of our spaceship "Voskhod-2" is a new important step in space research and its conquest. For the first time in history a man, being in the orbit of artificial earth satellite, will look on the earth not through a porthole.

We well understand the importance of implementing the assignment entrusted to us and we assure the Lenin's Central Committee of the Communist Party, Soviet Government, our dear countrymen, all near and dear ones, that we shall apply all our knowledge and skill, will power and energy to justify with honour the trust, shown to us.

Till we meet again, dear comrades, on our beloved earth!

(Tass)

<u>Pages from Biography.</u>

Pavel Ivanovich Belyaev was born on the 26th of June, 1925 in the village Chelischevo of Roslyatinskii area in Vologod region. He is a member of the CPSU since 1949.

In 1942, on finishing the ten-year school, he got a job at a factory initially as a turner, later an examiner of ready product.

In 1943, he voluntarily joined the ranks of the Soviet army and requested to be sent to flying school. His request was granted. In 1945 he finished the flying school.

As a fighter-pilot he took part in the war with Japan and thereafter continued to serve in various military units.

The command highly praised the flying qualities of Pavel Ivanovich, mentioning, that he flies boldly, with confidence.

In 1959 he got the rank of "Fighter-pilot second class".

In 19[illegible] he, as one of the best pilot-commanders, was sent to Red-Banner Air-Force Academy, which he finished in 1959.

At present Pavel Ivanovich is taking a correspondence post-graduate course in the Red-Banner Air-Force Academy.

The commander of spaceship Col. Belyaev has successfully completed the special training. He knows perfectly the equipment of the spaceship. He is well prepared as commander of the spaceship. He is a good parachutist.

For good service in the Soviet Army awarded order of the "Red Star", medals "For combat merit", "For victory over Germany", "for victory over Japan", "XXX years of Soviet Army and Fleet", "40 years of Armed Forces of USSR", "for faultless service" I and II grade.

He is married and has two daughters - Irina, born in 1949 and Lyudmila, born in 1955.

His father died in 1959, mother - in 1963.

Leonov Aleksei Arkhipovich was born on the 30th of May, 1934 in village. Listvyanka of Tisulskii area in Kemerov region. He is a member of CPSU since 1957.

In 1953 he enters flying school. Having finished with distinction Chuguev Air Force School of pilots Lenov served in various units of the Air Force.

The command speaks well of Leonov, valuing in him good flying qualities: self-control, composure, high discipline. He was awarded rank of "Fighter-pilot third class". He is a good parachutist, has completed 115 jumps with parachutes of various type. In 1960 he got the rank of "Instructor of air-borne troops".

As a member of the crew pilot-cosmonaut Leonov has successfully completed special training, knows perfectly the construction of the spaceship and is quite prepared for carrying out composite tasks during the space flight.

Lt. Col. Leonov is studying in Zhukovskii Aeronautics Academy.

For conscientious service in the Soviet Army he has been awarded Order of the "Red Star" and medals "40 years of Armed Forces of USSR" and "For faultless service" III grade.

Comrade Leonov was elected for Deputy Secretary of the Primary Party Organization. He is editor of a wall-paper, likes drawing - his drawings from the cosmodrome can be seen in periodicals.

Aleksei Arkhipovich grew up in a large and united family. His father is at present a pensioner. Mother is a housewife.

Aleksei Arkhipovich is married, has one daughter Victoriya, born in 1961.

"Pravda", 19th March, 1965.

(Tass)

Tass Communique on the Flight of Spaceship "Voskhod-2".

On the 18th of March, at 17 hours Moscow time, completing fifth revolution around the earth, the crew of spaceship "Voskhod-2" were working according to flight program. After the exit into space of the second pilot-cosmonaut Leonov and a brief rest the condition of the spacemen was determined from data of telemetric medical-control systems. They were found to be quite fit. Pulse 70-72. Respiration rate 18-20. The present conditions are maintained in the cabin. Temperature 19°C, pressure 760 mm of mercury. The spacemen ate their meal with an appetite, thereafter in accordance with the program comrade Leonov had a rest. The commander of the spaceship Col. Belyaev carried on astronavigational observations and determinations.

Greetings were transmitted from aboard the spaceship "Voskhod-2" to peoples of the Soviet Union, Europe, Asia and Africa.

At 21 hours Moscow time the spaceship completed its eight revolution.

On the 19th of March at 5 hours 30 minutes Moscow time the spaceship "Voskhod-2" completed its thirteenth revolution around the earth.

During the night the spacemen slept in turns. They both rested, had their breakfast and feel quite well. Respiration rate 18-20, pulse - 72-78.

Radio-communication with cosmonauts Belyaev and Leonov, as well as processing of the received telemetric information from aboard confirmed, that all the systems aboard operate normally. Pressure in the space cabin 1.2 atm. Temperature 18°C. Humidity 45%.

During the past night the work on spaceship was conducted exactly in accordance with the program.

Flying above Australian continent, the spacemen transmitted greeting to the people of Australia.

"Pravda", 20th March, 1965.

Tass Communique, Program of Scientific Research is Fully Implemented.

On the 19th of March at 12 hours 02 minute Moscow time spaceship "Voskhod-2", piloted by a crew consisting of the ship's commander Col. Belyaev and co-pilot Lt. Col. Leonov has safely landed in the area of Perm city.

The landing was implemented by the spaceship commander Col. Belyaev with the use of mainual control system.

Comrades Belyaev and Leonov feel quite fit.

The program of scientific research is fully completed. During the flight a composite scientific and technical experiment was conducted on the exit into space of the cosmonaut in a special space suit with an independent life support system, which opened out a new stage in the mastering of space by a man. Material, obtained in the flight of spaceship satellite "Voskhod-2", is being processed and analysed.

"Pravda", 20th March, 1965.

To Communist Party and the Whole Soviet People! To Peoples and Governments of the Whole World.

The address of the Central Committee of the CPSU, Presidium of the Supreme Council of USSR and the Government of the Soviet Union.

The Soviet people have achieved a new outstanding success in research and mastering of space.

Soviet [illegible] "Voskhod-2" with a crew of spaceship commander comrade Belyaev and copilot comrade Leonov was placed into earth-satellite orbit on the 18th of March, 1965.

During the flight pilot-cosmonaut comrade Leonov has come out from the ship and, having implemented the required scientific observations in space, returned to the spaceship. To accomplish the man's exit into space and his return the spaceship "Voskhod-2" was equipped with special technical devices. The commander of the spaceship pilot-cosmonaut Belyaev during the experiment controlled equipment for the exit into spase, observed the state of Leonov and maintained continuous contact with him, ensuring safety of this unprecedented test in space. The cosmonaut Leonov stayed in space conditions for about 20 minutes, including the 10 minutes outside the ship.

Thus, during the flight of the spaceship "Voskhod-2" for the first time in history a man stepped directly into space. This is a great scientific feat, accomplished by the crew of spaceship "Voskhod-2".

Having completed during the 26 hours more than 17 revolutions around the earth and covering a distance over 720 thousand km, the multi-seater spacecraft "Voskhod-2" landed on the Soviet soil in the area of Perm city. All the systems, equipment and instruments of the spaceship operated normally and faultlessly throughout the flight. Problems set to the crew of the spaceship were carried out fully. The spacemen feel well.

The exit of a man into space, accomplished during the flight of "Voskhod-2", opens out a new era in the conquest of space. This unparalleled experiment proves the possibility for a man not only to fly inside the spaceships, but also to be active in space, implementing observations and other operations, - in a word, to work in space. Hence arise the realistic prerequisites for the resolution of most difficult problems, including the flights and landings on the moon and on other planets of the Solar System.

Observations, implemented during the flight of spaceship "Voskhod-2", made a new contribution to the world science.

The courageous crew of the spaceship "Voskhod-2" have increased even more the space fame of our socialist motherland. The whole world once again saw the superiority of the Soviet space technique: our powerful and exact rockets, perfect spaceships, their equipment, the whole system for assuring safe man-in-space flights. It has shown once again, that the mind and knowledge of the Soviet scientists, genius of designers, skillful hands of workers are capable of resolving any problem, set to them by the Communist Party and Soviet Government. In conditions of socialism the talents and capacities of Soviet people are flourishing [illegible]. Socialism gives birth daily to new heroes, whose feats astonish the world. Our mightly socialist industry have reached such peaks, that it is capable to bring to life the most daring ideas, which only yesterday seemed fantastic.

The feat in space, heroism and fearlessness, shown by comrades Belyaev and Leonov, fill with pride and joy the hearts of Soviet people, raise a new tide of Soviet patriotism and readiness to do all that is necessary for even greater flourishing of our motherland. Jointly with the Communist Party the Soviet people are proud of achievements in creative labor of the scientists and designers, engineers and workers - creators of the spaceship "Voskhod-2" and of all those, who assured its faultless flight.

The flight of spaceship "Voskhod-2", just as the preceding ones, serves the cause of peace and progress. The Soviet Government has repeatedly stated and today again solemnly declares. That the Soviet Union follows and will unswervingly follow the policy of peace both on earth and in the space. This policy is based on the principles of socialist order. The Soviet Union does not threaten any country, strives toward business cooperation with all the nations. The Soviet Government proposes general disarmament and resolution of International controversies by discussions.

Struggling for the cause of peace and friendship between peoples, the Soviet Union jointly with other socialist countries will henceforth also take all measures, open to it, to suppress the attempts of aggressive imperialist powers to aggravate the international situation. The Soviet people firmly condemn the aggressive policy of U.S.A. in South Vietnam, and their provocative attacks on the Democratic Republic of Vietnam. Our sympaties and our support are entirely on the side of people, fighting for their freedom, independence and social progress. In the face of imperialistic provocations the peoples of socialist countries, all those, who value the cause of peace, are called upon to close their ranks even tighter and to struggle even more actively for the cause of peace in the whole world.

The Soviet people know very well, that the most reliable guarantee of peace is to consolidate in every possible way the might of Soviet Power. Workers, peasants, intelligentsia all the laborers of our motherland increase its might by their selfless labor. Inspired by the feat of heroes-cosmonauts comrades Belyaev and Leonov they will achieve new successes in creative work in the name of building bright communist society in our country.

Long live the Union of Soviet Socialist Republics - the birth land of cosmonautics!

Glory to heroic Soviet cosmonauts!

Long live Soviet people - builder of communism, courageous fighter for peace and happiness of nations!

Let the cooperation of all countries in the mastering of space be flourishing!

Central Committee of CPSU	Presidium of the Supreme Council of USSR	Council of Ministers, USSR

For the Victory of Communism.

To scientists and designers, engineers, technicians and workers, all groups and organizations, participating in the accomplishment of the flight of a crew of spacemen on the multi-seater spaceship "Voskhod-2".

To Soviet cosmonauts comrade Belyaev Pavel Ivanovich, comrade Leonov Aleksei Arkhipovich.

Dear comrades, friends!

Our socialist motherland successfully continues the assault on space. The space flight has just been completed of the multi-seater spaceship satellite "Voskhod-2". The Soviet people and the whole mankind came to know the names of the new heroes in the conquering of space - commander of the spaceship "Voskhod-2" - pilot cosmonaut comrade Belyaev and co-pilot cosmonaut comrade Leonov.

The flight of spaceship "Voskhod-2" has opened a new, extremely important page in the history of space conquest. In the Soviet Union for the first time in the world a man has stepped out of the spaceship and free floated in space. This difficult, requiring unusual daring experiment was accomplished by pilot-cosmonaut comrade Leonov with participation of the spaceship's commander pilot cosmonaut comrade Belyaev. Comrade Leonov has successfully carried out outside the ship the required investigations and safely returned to the ship.

By means of the latest special TV system aboard the exit of comrade Leonov into space, his work outside the ship and return to spaceship could see with their own eyes millions of the earth's inhabitants.

The crew of the spaceship "Voskhod-2" has fully implemented the composite science research. All data of this space trip is a new outstanding contribution to Soviet and universal science.

For the first time in history a man has opened a door into universe, he came out to work directly in the outer space.

The whole Soviet people is proud of the new achievement of our motherland in the space conquest and limitless courage of the spacemen comrades Belyaev and Leonov. Raised by the Communist Party they have overcome all the difficulties of unusual space flight, carried out with distinction the assignment of the Party and the Government, increased the space fame of the Soviet Union.

We heartily congratulate you, dear comrades Belyaev Pavel Ivanovich and Leonov Aleksei Arkhipovich, with successful accomplishment of your space flight on spaceship satellite "Voskhod-2" and implementation noble assignment of the Soviet motherland of entrusted to you.

The Central Committee of the Communist Party of the Soviet Union, Presidium of the Supreme Council of the USSR and the Council of Ministers USSR sincerely congratulate also scientists, constructors, engineers, technicians, workers, medicos - all comrades, who participated in construction of improved multi-seater spaceship satellite "Voskhod-2", its new systems and equipment, in preparation and implementation of space flight of a crew of Soviet cosmonauts, in the accomplishment of the first in the world exit of a man from the spaceship into the outer space.

CC of CPSU, Presidium of the Supreme Council of USSR, Council of Ministers, USSR are glad to note, that all the systems and equipment of the spaceship "Voskhod-2", in particular the system for the man's exit from the ship and his return into cabin, worked faultlessly. Thereby, once more the high level and excellent quality of the Soviet space technique were demonstrated to the whole world.

Glory to the Soviet scientists, designers, engineers, technicians and workers, who opened a new horizon in the space conquest!

Glory to the new heroes of space!

Long live Lenin's Communist Party of the Soviet Union-inspirer and organizer of all the victories of the Soviet people!

Let us glorify our socialist motherland by feats in labor for the victory of communism!

Central Committee of CPSU	Presidium of the Supreme Council of USSR.	Council of Ministers USSR

"Pravda", 20th March, 1965.

To Central Committee of the Communist Party, Presidium of the Supreme Council of USSR, Council of Ministers USSR

Reporting: the assignment of the Communist Party, Soviet Government successfully carried out. All the systems of the spaceship operated well. We feel fit. Many thanks for the trust in us.

Cosmonauts Belyaev Leonov

"Pravda", 21st March, 1965.

Decree of Presidium of the Supreme Council of USSR for Conferring the Rank of the Hero of the Soviet Union on Pilot Cosmonaut Comrade Belyaev P.I.

For participation in the accomplishment of the first in the world exit of a man from the spaceship into the outer space, implemented during the flight of the piloted spaceship satellite "Voskhod-2", to confer the rank hero of the Soviet Union with award of the Order of Lenin and medal "Gold Star" to pilot cosmonaut commander of the spaceship "Voskhod-2" comrade Belyaev Pavel Ivanovich and to set up a bronze bust of the hero in Moscow.

A. Mikoyan

Chairman, Presidium of the Supreme Council, USSR.

M. Georgadze,

Secretary, Presidium Supreme Council of USSR.

Moscow, Kremlin, 23rd March, 1965.

Decree of the Presidium of the Supreme Council, USSR for conferring the Rank "Pilot Cosmonaut USSR" on Comrade Belyaev P.I.

For the accomplishment of the space flight on spaceship satellite "Voskhod-2" to confer the rank "Pilot cosmonaut of USSR" on the citizen of the Soviet Union comrade Belyaev Pavel Ivanovich.

A. Mikoyan,

Chairman, Presidium of the Supreme Council, USSR.

M. Georgadze,

Secretary, Presidium of the Supreme Council, USSR.

Moscow, Kremlin, 23rd March, 1965.

Decree of the Presidium Supreme Council of USSR on Conferring Rank Hero of the Soviet Union to Pilot Cosmonaut Leonov A.A.

For implementation of the first in the world exit from spaceship into the outer space, accomplished during the flight on piloted spaceship satellite "Voskhod-2", to confer the rank hero of the Soviet Union with award of the Order of Lenin and medal "Gold Star" to pilot cosmonaut comrade Leonov Aleksei Arkhipovich and to set up bronze bust of the hero in Moscow.

A. Mikoyan

Chairman, Presidium of the Supreme

Council, USSR.

M. Georgadze

Secretary, Presidium of the Supreme

Council, USSR.

Moscow, Kremlin. 23rd March, 1965.

Decree of the Presidium of the Supreme Council of USSR on Conferring the Rank "Pilot Cosmonaut USSR" on Comrade Leonov A.A.

For accomplishing space flight on spaceship satellite "Voskhod-2" to confer the rank of "Pilot cosmonaut USSR" on the citizen of Soviet Union comrade Leonov Aleksei Arkhipovich.

A. Mikoyan,

Chairman, Presidium of the Supreme

Council of USSR.

M. Georgadze,

Secretary, Presidium of the Supreme

Council of USSR.

Moscow, Kremlin. 23rd March, 1965.

"Pravda", 24th March, 1965.

Press-Conference on the Heroic Flight of Cosmonauts P.I. Belyaev and A.A. Leonov.

The spacious Assembly hall of Moscow State University on Lenin Hills is filled to capacity. The press-conference was held here, called by the Presidium of the Academy of Sciences USSR and the Ministry of Foreign Affairs USSR. It was dealing with the outstanding victory of the Soviet people in the mastering of space and meeting with pilots cosmonauts Belyaev and Leonov, who for the first time in history stepped out from the spaceship satellite "Voskhod-2" into the outer space.

Present at the conference were Soviet and foreign journalists, members of the diplomatic corps, scientists, students, workers of various organizations. Great is the interest, shown by the universal public for the new victory of the Soviet space conquerors. Thunder of applause greets the appearance in Presidium of the hero spacemen and scientists, who brought fame to our motherland by the new historic accomplishment in research of the limitless space of the universe.

Opening Address of M.V. Keldysh, President of the Academy of Sciences, USSR.

The Soviet people systematically and consecutively carried on the study and mastering of the outer space. Our country has built up an advanced space industry, which permits Soviet scientists and engineers to resolve grandiose problems of penetration into the depths of the universe.

The groups at Research Institutes and designing offices work on construction of spaceships, equipment, various systems and constructions, calculate space routes.

From the first in the world artificial earth satellite, first moon shots to spaceships, piloted by Soviet people, our science and technique demonstrated to the whole world, what heights the Soviet people have reached under the leadership of the great Lenin's party.

We had to resolve one of the most principal problems - a man's exit from the spaceship directly into the outer space. Resolution of this problem opens out new great possibilities for implementing the most distant flights of a man to the moon and other celestial bodies, for construction of inhabitated interplanetary stations.

Now we all know, that the flight with the exit of cosmonaut from the spaceship "Voskhod-2" into the outer space was a complete success.

The accomplishment of this experiment is one of the most remarkable performances in the way of mastering the space.

This event marks the beginning of entirely new stage in the research of the universe. Now new great prospects are being opened out for construction of orbital stations, for the junction of spaceships in orbit, carrying out of astonomical and geophysical investigations in space. In the near future it will be possible to create in earth orbit a space research institute, in which scientists will be able to work of most diverse specialities.

Dear Pavel Ivanovich and Aleksei Arkhipovich!

To mark the outstanding achievement in the sphere of cosmonautics - first exit of a man into the outer space the Presidium of the Academy of Sciences USSR has decreed to award you gold medals with the name of K.E. Tsiolkovskii, the founder of space flights. It is my pleasure to carry out this duty.

Permit me to consider the press-conference open.

Address of Colonel P.I. Belyaev.

On the 18th of March, 1965 at 10 hours Moscow time a powerful carrier-rocket placed into earth satellite orbit spaceship-satellite "Voskhod-2", the commander of which was myself and the co-pilot - Lt. Col. Leonov Aleksei Arkhipovich.

Having completed during the 26 hours over 17 revolutions around the earth and covered over 270 thousand km, the two-seater spaceship "Voskhod-2" safely landed on the 19th of March at 12 hours 02 minute Moscow time in the area of Perm city.

The flight of spaceship "Voskhod-2" has shown once more, that the mind and knowledge of the Soviet scientists, genius of designers, technicians are capable of constructing perfect spaceships and carrier-rockets.

The assignment planned one-day flight in the earth satellite orbit with experiment of exit from the spaceship into the outer space. It was envisaged to carry out research which included medico-biological experiments, resolution of space navigation elements, observation and study of the earth's atmosphere.

The flight of spaceship "Voskhod-2" was preceded by long and tedious preparation of the crew.

Since the spaceship "Voskhod-2" was different from the preceding vehicles and the program planned an experiment on the man's exit into the outer space, our preparation was considerably more complex. We were in close contact with designers, who constructed the ship and participated in the tests of its various systems. Most of the training was conducted on a training vehicle. On this vehicle Leonov and myself prior to automatics worked out interaction at various branches of the flight and specially during the period of his exit into the space and return to the ship.

If I was asked, whether all this is easy or difficult, I would have answered: not easy!

As I have said, the crew was faced with an extensive program of experiments, scientific research, based on the exit of a man into the outer space.

The program has been fully implemented. The experiment on the man's exit into space we began immediately after we were placed into orbit. My friend Leonov carried out all the preparations for the exit into space and impatiently waited for my command. He wanted to jump out into space even before the time marked by the program, but I restrained him. The program is a program and I as the commander of the crew was responsible for its implementation. Having confirmed, that all the life support systems of Leonov functions normally, his pulse and respiration normal, I gave the command at prescribed time for the exit into space.

I had a [illegible]le telephone connection with Leonov, and devices fitted in the space cabin enabled me to check the work of the independent life support, as well as the pulse and respiration.

During the exit and the stay of Leonov in space effect was investigated of mass transfer on the ship's behavior. As soon as Leonov shifted to one or another side of the ship, as it sensitively reacted to these shiftings.

All the movements on the external shell of the spaceship and impacts, were clearly felt inside the ship. Therefore, besides all the systems, provided for the control of the spaceman, who is outside, there was additional "sound" system of checking.

Throughout the flight all systems and equipment of the spaceship "Voskhod-2" operated normally. Temperature in the cabin was about +18°C, humidity 35-40%, pressure 1 atom. For convenient implementation of individual scientific experiments and observations we partially freed ourselves from the space suit, in particular removed the helmet, boots, gloves and I must say, were feeling well.

In accordance with the flight program we had to land on the seventeenth revolution by automatic descent with the use of doubling orientation systems. In the case of failure of the automatic landing system the cosmonauts could always land by manual landing system with the use of duplicating orientation systems. Our cosmonauts since long had a wish to use the manual landing system, carefully worked it on land during training and were ready to use it in flights. We were also getting ready for that. I must admit, that we, pilots cosmonauts, were secretly even angry with the automatics, which deprived us of the possibility to do something, that we wanted to do ourselves. But, as though to defy us, it always worked perfectly.

And when in preparation for landing by the automatic system of descent we noted some abnormality in the working of the solar orientation system, we were even glad. Now we had a chance to land manually and thereby to uncover one more remarkable capacity of the Soviet piloted, now in the full sense of this word, spaceships. Frankly speaking, we were only afraid of one thing - that we wont be allowed to do it. You see, the automatic descent system could have been used on the next revolution.

The 30 seconds, which required to take decision on report and request of permission to land manually, seemed very long to us. Finally, the "go ahead" was given for the manual landing on the eighteenth revolution. The earth was confident of our power and had no doubt, that we will manage the problem.

The manual landing system operated faultlessly, and we landed approximately, where estimated, but with some overflight due to the novelty of this landing. This is one more convincing proof of the possibilities of our space technique, ensured against any incidents and unexpectedness.

To implement successfully the landing of the spaceship "Voskhod-2" helped me the qualities of the fighter-pilot. The manual landing system of the spaceship is a reliable system and may successfully be used in subsequent flights.

The landing was accomplished with the use of soft-landing system, which has already been used on the spaceship "Voskhod". This system operated perfectly and quite justifies its name.

On landing we were met on our native soil by the workers of Perm, who warmly welcomed us.

On the day of our return to Moscow the USA has launched into earth orbit a piloted spaceship "Gemni" with cosmonauts Grissom and Young. This is a national achievement of USA. We congratulate the brave American cosmonauts.

Let the flights of our and American cosmonauts be directed to uncovering the secrets of the universe in the interest of science and for the good of all mankind.

Address of Lt. Col. A.A. Leonov.

Before passing on to the actual statement, I consider it my duty to tell you about the part of preparation, the overture, so to say, which precedes the flight itself. The five steps in the void were preceded by gigantic work. The spaceship and air-lock chamber were being modelled, deep-vacuum conditions were created in thermal environment simulation chamber. And in these conditions we, dressed into space suits, worked out stage by stage and got practically experience in the whole process of air-locking.

Immediately on insertion into orbit we began preparations for the experiment. Prior to stepping into air-lock chamber, while still in the space cabin, I put on with the help of commander the haversack with independent life support system and connected with it. We equated the pressure in the chamber and in the cabin. Then we opened the hatch from the cabin into the chamber and I floated in. I let the pressure into the space suit, checked the latter's air-tightness, checked the closure of the helmet and position on it of the light-filter. Having checked the oxygen feeding into space suit and once more mentally going through all the operations for exit from the spaceship, I got ready to step out into the space.

Pavel Ivanovich closed the hatch of the space cabin. Relieving pressure from the chamber, the commander opened the exit hatch. A blinding shaft of sunlight flooded the air-lock chamber. The way into space abyss was open! I could not contain my impatience to take a look outside. I ask the commander, but everything should go according to the program, there is no hurry. I waited for a little while. At last everything is ready, I can come out.

The immensity of space was in front of me in all its undescribable beauty. First look on the earth. It floated majestically in front of my eyes. It appeared flat. And only the curvature around the edges reminded one, that it is a globe. In spite of the quite dense light filter, I saw bright clounds, the azure of Black Sea, and edge of cost line, Caucasian Range, the Novorossiisk bay. It was the time to leave the ship and step out into space.

Without hurry I scrambled out from the air-lock, got separated from the ship. I moved away from it further and further. The halyard, by means of which I was attached to the ship, stretched to its full length and my moving away from the ship has ceased. Slight force of pushing away from the ship resulted in its slight angular shifting and in front of my eyes began gradual unfolding of our wonderful space vehicle.

I expected to see sharp contrasts of light and shadow, but there was nothing of the sort. The parts of spaceship in the shadow were quite well litten up by the sun rays, reflected from the earth.

I slightly pulled on the halyard and began gradually approaching the ship. Then again I pushed away from the ship and, turning about the transverse axis, began gradually moving away from the ship. Bright unwinking stars against the background of a dark-purple changing into velvet blackness bottomless sky were replaced by a view of the earth. In front of me floated majestic green massives, I recognized Volga, mountain range of the old ural, then I saw the Ob and Yenisei rivers, as though I floated above a huge colorful map. Distance did not permit to determine towns and topographical details, but to those, who are finiliar with the brush and easel it is difficult to find a more majestic picture, than the one, which was opening in front of me. The bright sun, as though nailed into the blackness of the sky, penetrating with its rays through the visor of the helmet, appreciably warmed the face. Then again stars and the vastness of earth.

After some time I quite energetically pulled myself by the halyard and had to defend myself with hands from the ship, which begun moving swiftly toward me. First of all I thought of avoiding hitting against the ship with the helmet's porthole. But, on reaching the air-lock, my hands absorbed the shock of the impact. This was very easy and I became convinced, that by adapting oneself it is possible to get coordinated in these unusual conditions.

I was feeling perfectly well, my mood very cheerful, I did not feel like parting with the free space, and even, getting the command for return, I once more pushed off from the edge of the hatch, to check, why there are angular velocities at the first instant after the jolt. This has shown, that the slightest shifting in direction of the jolt force resulted in rotation in the corresponding plane. Apparently, people, who are going to work in space, will have to learn how to fix the body in condition of weightlessness.

As regards the so called psychological barrier, which should have been an insurmountable obstacle to a man, getting ready to meet face to face the space abyss, I have felt no barrier and even forgot, that it can be. I had no time to think about it. Nevertheless, those 20 minutes, which I have spent in space, including the 10 minutes outside the ship were only the "[illegible]" of the flight on spaceship "Voskhod-2". I knew that and therefore tried not to waste a single second.

Moreover, a most significant role was played by the fact, that I was constantly in touch with commander, my best friend, and with the earth. I did not feel alone in space. Finally I did not doubt the quality of the space suit, reliability of equipment and life support system. Unfortunately the time has passed very quickly and the last moments received for being outside the ship. I took off the camera, which recorded my exit into space on a film, and tried to enter the hatch, but it was not so easy. The movements in inflated space suit are still somewhat restricted. Considerable physical effort was required and my good-bye with space was somewhat protracted. Finally I was again in the air-lock and after a while was in the cabin next to Pavel Ivanovich, who congratulated me on the safe completion of the exit task.

As regards the rest of the flight you heard from Pavel Ivanovich. I would only like to say a few words about those unforgettable impressions, about the gamut of colors, which we were lucky to observe.

In conclusion I would like to say, that the preliminary results of our space flight permit to draw some conclusions. The exit from spaceship into open space is quite possible and is not anymore something mysterious for a man. A man in a special space suit with appropirate independent life support systems may not only exist in space, but also implement certain purposeful and coordinated operations. Physical work and scientific research are possible in the open space.

The way for mastering the outer space is not easy. But I'am sure, that Soviet science, technique, genius of our people will penerate progressively deeper into the secrets of the universe and use them for the good and happiness of mankind.

Pravda, 27th March, 1965.

TASS COMMUNIQUE, FLIGHT OF THE NEW SOVIET SPACESHIP "SOYUZ-1".

Today, 23rd of April 1967, at 3 hrs. 35 min. Moscow time the Soviet Union has placed into earth orbit by means of a powerful carrier-rocket a new spaceship "Soyuz-1". The spaceship "Soyuz-1" is piloted by a citizen of Soviet Union pilot cosmonaut of USSR Hero of the Soviet Union Flt. Engineer Col. Komarov Vladimir Mikhailovich, who previously accomplished space flight on spaceship "Voskhod".

The purpose of the space flight is the following:

- testing of the new piloted spacecraft;
- operation of systems and construction elements of space ship in conditions of space flight;
- carrying out extended scientific and physico-technical experiments and investigations in conditions of space flight;

- continuation of medico-biological investigations and effect study of various pace flight factors on human organism.

The spaceship "Soyuz-1" is placed into an orbit close to calculated. According to preliminary data orbital period of the spaceship is 88.6 min., distance at perigee - 201 km, at apogee - 224 km; orbital inclination - 51°40'.

A reliable two-way radio communication has been fixed with the spaceship "Soyuz-1".

According to report of the ship's commander comrade Komarov and telemetry data, he has quite satisfactorily stood the orbital insertion and transition to weightlessness.

He is feeling quite fit.

Vladimir Mikhailovich Komarov has begun implementation of the planned flight program.

Communications from aboard the spaceship "Soyuz-1" are transmitted on frequencies 15.008; 18.035; 20.008 Mcps.

The systems aboard the spaceship function normally.

Further communiques on the progress of the flight will be transmitted by all the radio-stations of the Soviet Union.

Pravda, April 24, 1967.

TASS COMMUNIQUE ON THE FLIGHT OF SPACESHIP "SOYUZ-1"

8 hours.

The Soviet spaceship "Soyuz-1" continues its orbital flight. At 8 hours Moscow time the spaceship "Soyuz-1" has completed third revolution around the earth. The ship's commander pilot-cosmonaut Komarov is conducting the planned program of research.

Flying above the Soviet Union territory, comrade Komarovskii transmitted from aboard the spaceship greeting to the people of the Soviet Union: "On the eve of glorious historic event - 50th anniversary of the Great October Revolution I transmit my ardent greetings to the peoples of our Motherland, paving the way to communism for mankind."

According to report of comrade Komarov and telemetry data the cosmonaut feels well, his pulse rate is 82, respiration - 20.

Steady radio communication is being maintained with cosmonaut Komarov.

10 hours.

Soviet spaceship "Soyuz-1", at 10 hours has completed fifth revolution around the earth.

According to report of pilot cosmonaut Vladimir Komarov, the flight program is being successfully implemented, he is feeling well, his mood is cheerful.

From aboard the spaceship Vladimir Komarov transmitted ardent greetings to courageous Vietnam people and best wishes to the people of Australia:

"I warmly greet the courageous Vietnam people, conducting selfless struggle against the bandit aggression of American imperialism, for liberty and independence".

"Best wishes to industrious Australian people".

According to data of telemetric measurements the pressure and temperature are within the limits; temperature in psace cabin 16°, pressure 750 mm of mercury.

Continuous radio-connection is maintained with V.M. Komarov.

From 13 hours 30 minutes till 21 hours 20 minutes Moscow time the spaceship "Soyuz-1" will be flying outside the radio-visibility zone from the Soviet Union territory. In accordance with the flight program pilot cosmonaut V.M. Komarov will be resting.

22 hours 30 minutes.

Soviet spaceship "Soyuz-1" continues its orbital flitht. At 21 hours 20 minutes Moscow time the spaceship entered radio-visibility zone from the Soviet Union territory.

The ship's commander pilot cosmonaut Komarov reported, that the work is being implemented in accordance with the program, he is feeling well. According to report of V.M. Komarov and telemetry data the sanitary and hygienic conditions in the cabin are quite normal.

At 22 hours 30 minutes Moscow time the spaceship "Soyuz-1" has completed thirteenth revolution around the earth.

The tests of the new spaceship "Soyuz-1" are continuing.

Pravda, April 24, 1967.

TASS COMMUNIQUE ON THE DEATH OF PILOT COSMONAUT USSR HERO OF THE SOVIET UNION FLT. ENGINEER COL. KOMAROV VLADIMIR MIKHAILOVICH:

As informed on the 23rd of April 1967 a new spaceship "Soyuz-1" was placed into earth orbit in the Soviet Union for the purpose of the flying tests. The ship was piloted by the pilot cosmonaut of USSR Hero of the Soviet Union Col. Komarov Vladimir Mikhailovich.

During the test flight, which continued more than 24 hours, V.M. Komarov has fully implemented the planned program of operating the new ship's systems, and also the planned scientific experiments.

During the flight pilot cosmonaut V.M. Komarov maneuvred the spaceship, tested its various systems in different conditions and was giving a qualified estimate of the new ship's technical data.

On the 24th of April, when the test program was completed, it was was suggested, that he should finish the flight and land.

After implementation of all the operations, connected with transition to landing conditions, the spaceship has safely passed the most difficult and responsible branch of braking in dense layers of the atmosphere and has totally quinched the orbital velocity.

However, during the opening of the main parachute canopy at altitude of seven km, according to preliminary data, as a result of twisting of the top cord of the parachute the spaceship descended at high velocity, which was the cause of death of V.M. Komarov.

The untimely death of the outstanding spacemen test-engineer of spaceships Vladimir Mikhailovich Komarov is a great loss for the whole Soviet people.

By his work in the sphere of testing spaceships Vladimir Mikhailovich Komarov has given a priceless contribution to development and perfecting of space technique.

"Pravda", 25th April 1967.

DECREE OF THE PRESIDIUM OF SUPREME COUNCIL OF USSR ON AWARDING TO HERO OF THE SOVIET UNION PILOT COSMONAUT OF USSR KOMAROV V.M. OF SECOND MEDAL "GOLD STAR".

For heroism, courage and bravery, shown in the test flight of the new Soviet spaceship "Soyuz-1", to award to the Hero of the Soviet Union pilot cosmonat Komarov Vladimir Mikhailovich second medal "Gold Star" (posthumously) and to set up the a bust in the native place of the hero.

N. Podgorny, Chairman Presidium of the Supreme Council of USSR

M. Georgadze, Secretary Presidium of the Supreme Council of USSR.

Moscow, Kremlin.
24th April 1967.

"Pravda", 25th April 1967.

AUTOMATIC SPACE VEHICLES FOR INVESTIGATION OF DISTANT SPACE AND PLANETS OF THE SOLAR SYSTEM

TASS COMMUNIQUE ON THE LAUNCHING OF AUTOMATIC INTERPLANETARY STATION "VENUS-1"

In accordance with the program of space research the Soviet Union on the 12th of February 1961 has placed into orbit by means of improved multi-stage rocket a heavy artificial Earth satellite.

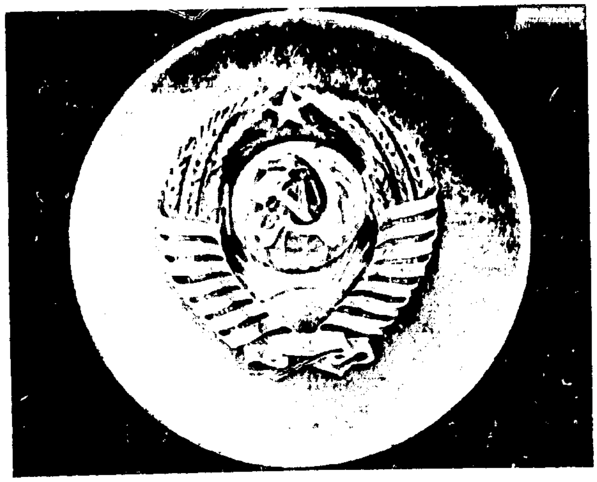
The same day a controllable space rocket took off from this satellite, placing on thepath to Venus an automatic interplanetary station.

The station will research the area of Venus in the second half of May 1961.

The main objects of this launching are the checking of methods for insertion of space object into interplanetary path, checking of super-distant radio-communication and control of the space station, scale verification of the solar system and a number of physical investigations in space.

The equipment on baord the interplanetary station is operating normally. The weight of the station is 643.5 kg.

Radio transmission from the automatic interplanetary station are being conducted on frequencies 922.8 megacyles per second on command from the earth.




The station is carrying a pennant with the State emblem of USSR.

Flight tracking of the automatic interplanetary station is being conducted by a special measuring center.

According to obtained data the station is moving along an orbit, close to calculated one.

On the 12th of February 1961 at 12 hrs Moscow time the station was at a distance of 126 thousand 300 km from the surface above a point of earth surface with geographical coordinates 86°40' and 6°04' N.

The successful Venus shot paves the first interplanetary path to planets of the Solar System.

FIRST FLIGHT TO VENUS

Movement of the Automatic Interplanetary Station

On the 12th February 1961 the flight began in the Soviet Union of automatic interplanetary station on the path to planet Venus.

After the launching of the artificial Earth satellite, moon shots and lunar orbiting, with the photographing of its other side began the new era in the mastering of space and

"Pravda", 13th February 1961.

research of Solar System planets and the first flight now of space vehicle to the nearest planet Venus.

Powerful engines acclearated the multistage rocket, increasing its velocity and altitude of flight above the Earth's surface. The control system was leading the rocket along a prescribed trajectory. When the rocket's velocity was upto to orbital, it separated from the heavy satellite, which carried the AIS. The satellite was moving on almost circular orbit with distance at perigee 6601 km, distance at apogee 6658 km and orbital inclination 65°.

The space rocket's take off from aboard the satellite took place at a prescribed point of orbit. When the flight velocity of this rocket in relation to Earth exceeded the orbital velocity by 661 m sec and the rocket left the orbit into prescribed point of space, the engine of the rocket was cut off and the AIS separated from it. Its free flight to Venus has begun. Thus for the first time a controlled vehicle was launched from aboard an artificial Earth satellite into an interplanetary path.

Further movement of the AIS is under the gravity effect of the Earth, the Sun and the planets. The Earth's gravity has a considerable effect on the movement of AIS at a distance upto a million km from the Earth's center. The sphere with aradius of a million km, surrounding the Earth is conventionally known as the earth activity sphere. After the exit from the earth activity sphere the movement of AIS is affected mainly by the attraction force of attraction due sun and it moves according to the same laws, as the planets of the solar system.

Within the earth activity sphere the AIS moved along a curve, which was almost a hyperoble. This curve lies in the plane, passing through the earth's center and invariably oriented in relation to the stars. This plane is similar to that, in which moved the satellite. With the withdrawl of the velocity of AIS in relation to earth gradually dropped. The AIS reached the limits of the earth activity sphere on 14th February at 23 hrs Moscow time and at this time had velocity of about 4 km per sec in relation to earth.

The velocity of AIS in relation to the sun is obtained by adding velocity vector of earth in relation to the sun and velocity vector of AIS im relation to the earth. At the moment of exit from the earth activity sphere the velocity in relation to the sun was 27.7 km per sec.

After this the movement of the AIS, just as that of the planets, is along an dlliptical orbit with the focus in the center of the sun. This orbit has:

aphelion distance - 151 million km;

perihelion distance - 106 million km;

inclination to the ecliptic - 0.5 degree.

The movement planes of earth, venus and AIS are at low inclination to each other.

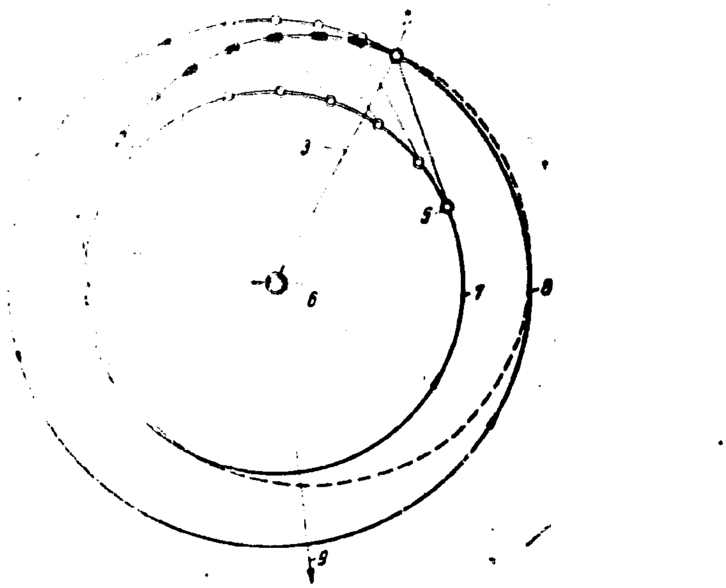


Figure 2. Movement of AIS in relation to the sun (in projection onto orbital plane of the Earth)

1- Position of the earth at the moment of AIS approach to Venus;
2- the Earth's position at the moment of take off;
3- line of the AIS orbital nodes;
4- position of Venus at the moment of AIS approach;
5- position of Venus at the moment of take off;
6- Sun;
7- orbit of Venus;
8- orbit of Earth;,
9- line to the point of spring equinox

Figure 2 shows the movement of AIS, earth and venus in projection onto the orbital plane of the Earth. The Earth and Venus move along the orbits almost circular. The simultaneous position of Earth, Venus and AIS are noined by the straight lines. At the beginning of the movement around the sun the rocket is lagging behind the Earth. Not long before the day of the spring equinox the Sun, AIS and the Earth will be approximately on one straight line. Thereafter, the rocket will outstrip the Earth in angular motion around the Sun. The distance from Earth to AIS throughout the flight to Venus will continuously increase and at the moment of approach will be 70 million km.

The angle between directions from the center of the Sun onto Earth at the moment of take-off and onto Venus at the moment of approach to it composes 120 degrees. The transit time of AIS till the approach to Venus will compose a little over three months. The approach to Venus will take place on the 19 – 20 of May 1961.

Venus, same as the Earth, has activity sphere (600 thousand km in radius). Within this sphere the Venus effect on the motion is predominant over that of the Sun. Motion in relation to Venus within its activity sphere will be taking place in trajectory, which is almost a hyperbola, with focus in the center of Venus.

Estimate from the received orbital measurements data shows, that AIS will enter deep into the activity sphere of Venus. Minimum distance of AIS from Venus with motion along the present trajectory should be less than 100 thousand km with total length of path 270 million km. This proves high precision of AIS insertion into its trajectory.

If the interplanetary station was a bright point, it would have been possible to observe from Earth movement of the Station against the background of motionless stars. Its path in celestial sphere is shown on the stellar map.

At the beginning of the movement the shifting of the station in relation to the stars was quick. At the exit from the earth activity sphere the station was in the region of sky on the boundary between Pisces and Mira constellations, in the center of triangle, formed by the stars beta of Aries, alpha of Pegasus and beta of Mira. By this time the angular movement of AIS in the sky vault was already very slow. In this branch the AIS moves in relation to Earth approximately along the radius.

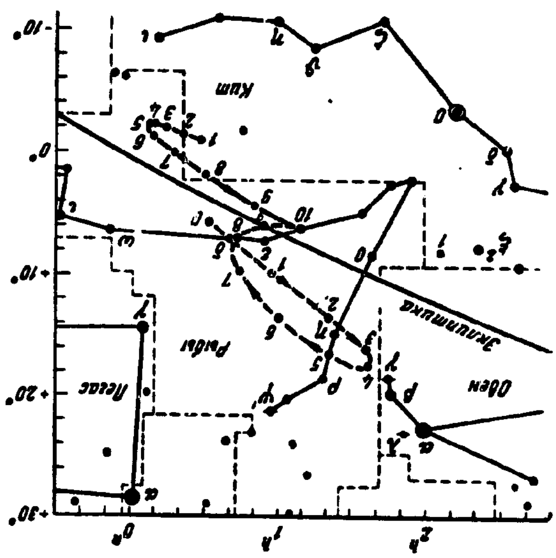


Figure 3. The visible movement chart of the automatic interplanetary station (continuous line) and of Venus (dotted line) in celestial sphere.

The figures show the position of the automatic interplanetary station and Venus every ten days of the flight. On the vetical axis are shown declinations in degrees, on the horizontal axis - direct ascension in hours (h).

Hence the movement of AIS in celestial sphere, as seen from the map, is similar to movementof planets. Before the beginning of April the AIS will be in the constellation of pisces, moving in the so called retrograde motion. At the beginning of April the AIS will begin to shift in celestial sphere by direct motion. The point, where retrograde motion changes to direct, is known as stagnation point. The direct motion among the stars will continue till the approach to Venus, which will take place not far from the upsilon star of the Pisces.

At the take off moment of the AIS the Venus was in the constallation Pisces, shifting among the stars by a direct motion. The direct motion gradually slows down, and at the end of March will come the stagnation of Venus. After the stagnation will begin the retrograde motion of Venus, which will continue till the beginning of May 1961, thereafter changing to direct motion. At this branch of the direct motion of Venus will take place the approach of the AIS with the planet.

In the following table are given the preliminary rounded-off distances of AIS from the Earth, Venus and Sun and the angles of direct ascent and declination every ten days after the take off.

Number of point on the drawings	Date (zero hrs universal time	Distance AIS from Earth mln. km	Distance AIS from Venus mln.km	Distance AIS from the Sun mln. km	Direct ascent of AIS in h and m	Declination of AIS
1	22 February	3.4	74	145	0h27m	$-1^{\circ}.0$
2	4 March	6.9	60	142	0h22m	$-1^{\circ}.5$
3	14 March	11	48	138	0h16m	$-2^{\circ}.0$
4	24 March	15	36	134	0h10m	$-2^{\circ}.25$
5	3 April	21	27	129	0h08m	$-2^{\circ}.25$
6	13 April	28	19	124	0h10m	$-1^{\circ}.25$
7	23 April	37	13	119	0h18m	$0^{\circ}.0$
8	3 May	47	7.5	115	0h32m	$2^{\circ}.0$
9	13 May	59	3.1	111	0h51m	$4^{\circ}.5$
10	19-20 May	70	less 0.1	109	1h09m	$6^{\circ}.5$

Selection of Trajectory

To accomplish the flight to Venus, it was necessary to select flight path, meeting a number of conditions. If the date of rocket take off and the date of AIS approach to Venus are decided, the AIS orbit in the Solar System, outside the Earth activity sphere, is determined unambigously. In this case the AIS, leaving the earth activity sphere, should have a quite definite velocity, both in magnitude and in direction. However, with unsuitable selection of dates for the take off and approach the required velocity will be so high, that acceleration of AIS of even very low weight will be unrealizeable by means of the most powerful technically feasible rockets. Therefore the dates of the take off and approach are selected with a view of getting the lowest possible velocity for the exit of AIS from the Earth activity sphere. In this case the velocity, which the carrier-rocket should impart to AIS during the acceleration period, also will be minimal.

The method of AIS acceleration by the carrier-rocket is very significant. With continuous operation of all the carrier-rocket stages the weight of effective load depends not only on the end velocity, which has to be imparted to AIS, but also on the angle of inclination of velocity to horizon. With high angles of inclination of velocity the attraction force of the Earth prevents acceleration. Therefore it is easier to impart the prescribed velocity in horizontal direction whereas the high inclination angles may result in excessive consumption of the fuel and great loss in the weight of the automatic interplanetary station. For the AIS to enter into earth activity sphere with velocity in required direction, the continuous aceleration may require end velocity, steeply inclined to horizon.

This can be avoided, if the acceleration method is applied with exit into interim satellite orbit. Satellite carrying the space rocket is inserted by carrier-rocket into circular orbit with minimum losses. The acceleration of the space rocket, which takes off from aboard the satellite, is done almost in horizontal direction. Having selected in appropriate way the orbital plane of the satellite, time and place of the take off from the satellite, it is possible to ensure exit of AIS into activity sphere with required velocity direction.

The availability of a powerful carrier-rocket and the take off from aboard the satellite have made it possible to place into interim orbit to Venus an AIS weighing 643.5 kg.

Using the take off from aboard the satellite, it is expedient to accelerate space vehicles not only with Venus shots, but also in the most diverse space paths.

As has already been mentioned, the dates of take off and approach to Venus are selected so, as to get the lowest possible exit velocity of AIS from the earth activity sphere. This determines a number of date ranges for the take off and approach, gainful from the viewpoint of the rocket's energetics. The acceptable intervals of the take off dates are 1 - 2 months and are repeated periodically approximately after 19 months. One of these intervals falls at the end of 1960 - beginning of 1961. And this was used in the launching on the 12th of February.

From the earth activity sphere the AIS comes out into elliptical orbit of periodical motion around the Sun. In this connection for various energetically gainful trajectories the flight time till the approach to Venus could considerably differ. There are flight paths, along which the rendezvous of AIS with Venus occurs during the first half of the AIS revolution around the Sun, in the second half of the revolution, etc.

For the shot on the 12th February the selection was made of a path, in which the rendezvous occurs during the first half of the revolution. The paths of other types have some disadvantages in comparison to this one: the flight time increases considerably, the dependence increases of the AIS deflection at the Venus on errors at the terminal acceleration. Moreover, the distance from Earth to Venus at the moment of approach to the planet is considerably greater for these trajectories, than in the present case.

For AIS to pass in direct vicinity to the planet, it had to be placed into calculated trajectory with high precision. Even with very low deviations in velocity, imparted to AIS in the terminal acceleration, it will fly past the planet at a considerable distance. Errors in velocity 1 - 3 m per second, with total velocity of 11 thousand m per sec., and error in direction of velocity 0.1-0.3 degrees may result in changing the minimum distance of AIS from Venus by 100 thousand km. The same magnitude of deviation is produced by an error in the take off time of rocket of 1 min.

Deflections of AIS path from Venus may also happen due to the fact, that the position of Venus is known only with a certain accuracy. Because of this deflection calculation of AIS from Venus may have errors, even exceeding the planet's radius. The main source of this error is the accuracy insufficient for this purpose in measuring the astronomical unit(mean distance from Earth to the Sun), which determines the scale of the Solar System.

A more exact knowledge of the astronomical unit is extremely important for space flight.

According to the above stated fact for the space vehicle to reach the planet the most exact measurements of the flight path are required along with it as a small correction of the movement during the flight to planet by means of special devices is also necessary.

With sufficiently accurate trajectory measurments on a greater branch of the AIS flight it is possible to verify the astronomical unit.

Control Center

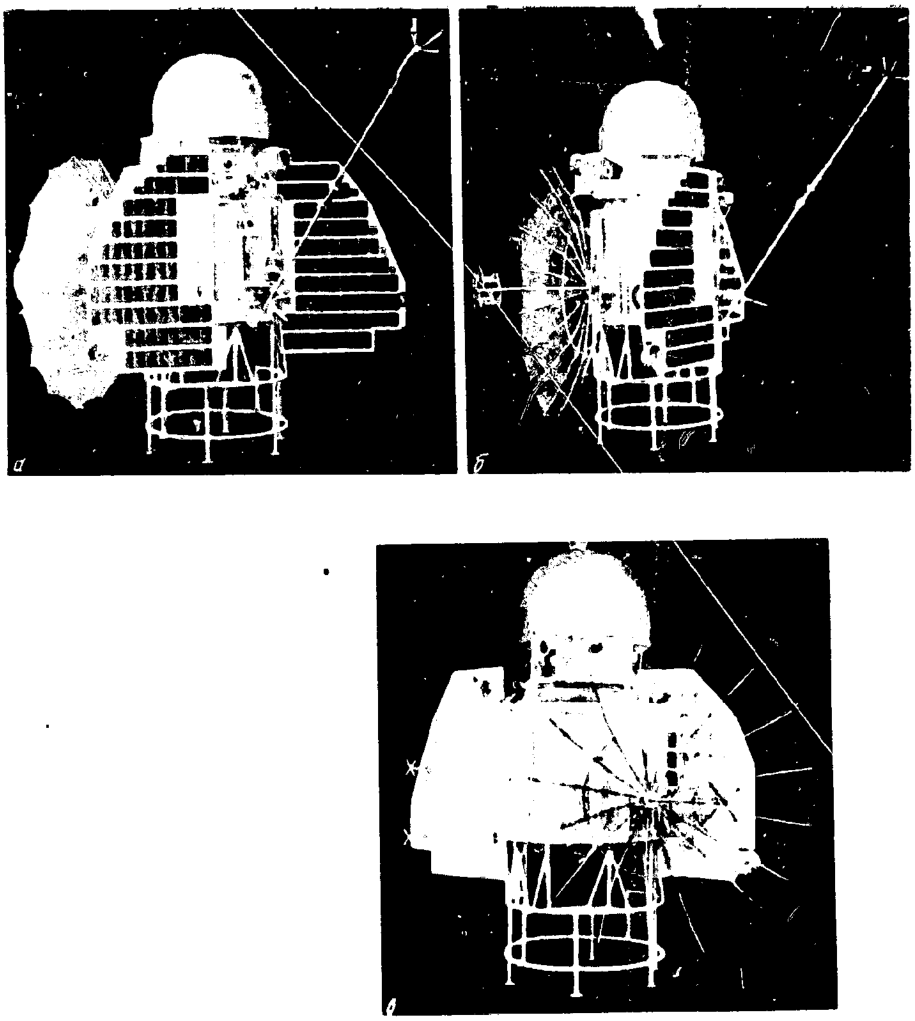
To control the AIS, determination of its orbit and two-way communication with AIS to a distance of upto hundreds of millions km, an automatic measuring device and a radio center has been set up.

The setting up of the center presented the Soviet scientists and engineers with a number of serious problems, connected with ensuring contact at enormous distances, with high demands of accuracy in determination of coordinates and of reliability in performance of equipment of a prolonged time.

The whole flight path of the space rocket could be conventionally broken up into three brances: the flight of the heavy artificial earth satellite, take off branch of space rocket from the satellite and the branch of AIS movement under the effect of attraction forces in direction of Venus.

The measurements of the trajectory elements of heavy satellite was conducted by special facilities on the territory of the Soviet Union. Information on the work of assemblies and units of the satellite were received by radiotelemetric stations, set up on the territory of our country, and also by special ships on the oceans.

The launching of the space rocket from the heavy satellite



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was controlled by telemetric systems.

After the separation of AIS operated the measuring center of the surface branch, meant for orbital and telemetric measurements. At each measuring center of the ground branch are set up special radio transmitters and tranceivers, parabolic antennas with programed guidance systems.

Determination of the actual orbit with withdrawal of AIS from Earth to a distance of more than 100 thousand km is conducted by radio facilities at the center of distant space communication The same center receives teleinformation and controls the equipment of the interplanetary station throughout its flight. The command radio line cuts in and cuts out the appropriate equipment of AIS, changes transmission rate of telemetric information, switches over power supply sources, etc.

Operation of all the facilities on the distant branch of AIS flight is done according to a special program, which determines the duration of communication sessions, their periodicity and working conditions of equipment.

For reception of radio signals at great distance the use is made of narrow-band low-noise receivers. This involves the necessity for sufficiently accurate calculation of received and emitted frequency with an estimate of Doppler reflection. To maintain constant frequency at the input of the narrow-band filters of receivers on the interplanetary station and at the measuring center, a predictable Doppler correction is introduced into received and emitted frequency.

In withdrawal of interplanetary station to distances, measured in tens and hundreds of millions km, the power of signal reaching the Earth is insignificant. Thus, for instance, with distance of 70 million km, only 10^{-22} watt will fall to one square meter of the earth surface. For reception of such low signals even with the use of superhigh-sensitivity receivers the antennas have to be of large area.

At the station of distant space communication Center large antennas were erected, permitting to receive radio signals from sources at enormous distance from Earth.

The antenna could be guided at any point of celestial sphere with accuracy upto a few angular minutes. The guidance programs are automatically input into computers, controlling the antennas.

All the data are transmitted through automatic line into coordination center, where the trajectory measurements are processed the movement of AIS is predicted by means of quick-acting computers and the antenna guidance programs are estimated. The Coordination center supervises all the ground services according to a planned program.

The Arrangement of the Station

The automatic interplanetary station is a vehicle, fitted with a complex of radio and scientific equipment, orientation and control system, thermal control system, power supply sources.

In construction the AIS is made in the shape of a pressurized body, consisting of cylindrical section with two end plates. Inside the pressurized body fitted on an instrument board is the airborne equipment and chemical batteries blocks. Outside the body is arranged a part of the scientific equipment sensors, two panels of solar batteries, shutters of the thermal control system and elements of the orientation system.

Attached to one of the solar batteries panels is a block of heat sensors for variation investigation of optical coefficients of various covers during the prolonged presence in the interplanetary space at different distances from the Sun. Moreover, outside the station's body are fitted four antennas. One of these - pencil - beam antenna - has the shape of a paraboloid about two meters in diameter and ensure connection with interplanetary station at great distance from the Earth and transmission of a great volume of information within a short time interval.

The two cross antennas, set up on the solar battery panel, have low-radiation pattern and are meant for communication at medium distance from the earth.

The omnidirectional aerial - rod 2.4 m in lengt - is meant for transmission of information and trajectory parameters determination in the near-earth branch.

Maximum dimensions of the station(without the antennas and solar batteries) are 2035 mm in length and 1050 mm in diameter.

Weight of the interplanetary station composes (43.9kg).

The panel of the solar batteries, the parabolic and rod antennas prior to the separation of the station from the space rocket are folded and open out immediately after the separation except, the parabolic antenna. The latter opens out on the approach to Venus.

The construction of the station ensures maintenance within the pressurized body of the initial gas pressure of about 900 mm of mercury throughout its flight.

The shutters of the thermal control system, fitted on cylindrical section, open and shut by rotating the radiation surface, correspondingly increasing or decreasing the removal of heat, emanated during operation of airborne equipment. The shutters and ventilators inside the body are controlled by means of independent airborne programing device with a system of temperature sensors, set up at points, most prone to overheating or overcooling. Thus the problem is resolving of providing normal temperature conditions for the airborne equipment throughout the whole flight path from the earth to Venus, in the station's approach to the sun at a distance of upto 110 million km, i.e. with power increment of solar radiation by more than twice.

The two panels of the solar batteries, being constantly oriented on the sun, provide for continuous recharging of chemical current sources throughout the flight path of AIS, ensuring power suppby of all the airborne systems and equipment.

The radio set of AIS implements the following:

- parameter measuring of the station's movement in relation to earth.

- transmission to earth of the results of measurements, conducted onboard by scientific instruments;

- transmission to earth of information on performance of airborne equipment, pressure and temperature within the object and on its body;

- reception from earth of radio-command for the control of airborne equipment operation on board the station.

Operation control of the airborne equipment of the station is done by transmission of commands on radio line from the ground centers, as well as by the individual airborne programing devices.

The orientation system of AIS resolves during the flight the following problems:

- elimination of spontaneous rotation of the station, obtained during separation from space rocket, which took off from the heavy artificial earth satellite;

- search for the sun from any position of the station and orientation of solar batteries on the sun during the whole flight period;

- orientation in the vicinity of Venus of the parabolic antenna toward the earth for obtaining higher rate of transmission of the scientific information and data on performance of airborne equipment to earth.

The AIS carries a complex of scientific instruments for physical measuring on the path earth-venus.

At present the measurements are being conducted by instruments, designed for space research far from planets. These include instruments for measuring:

- cosmic rays;
- magnetic fields in the range from a few single gammas to several scores of gammas;
- charged particles of interplanetary gas and corpuscular beams of the sun;
- for recording micrometers.

The AIS carries a pennant with the state emblem of the Union of Soviet Socialist Republics. The pennant is a model of earth, hollow sphere in construction 70 mm in diameter of titanium alloy. On the outside of the sphere is a picture of the counters of continents. The seas and oceans are of pale blue color, the continents - golden - yellow.

Inside the spherical pennant is a memorial model with the state emblem of USSR. On the other side of the medal in the center is a chart of the solar system with orbits of Mercury, Venus, Earth and Mars, and along the edge inscription - "Union of Soviet Socialist Republics -1961."

The reciprocal position of the planets corresponds to the moment of AIS approach to the venus planet.

The spherical pennant is placed into a special protective cover, the outside of which is formed by pentagon elements of stainless steel with the state emblem of USSR and inscription "Earth Venus 1961."

The launching of the automatic interplanetary station toward the planet venus opens out to science extensive prospects of direct study of the outer space and the planets of the solar system.

The first interplanetary path has been paved.

"Pravda", 26th February 1961.

TASS COMMUNIQUE ON THE LAUNCHED OF AUTOMATIC STATION "MARS-1"

In accordance with the program for research of space and planets of the solar system, a Mars shot was accomplished in the Soviet Union on the 1st of November 1962.

This type of shot was implemented for the first time.

The last stage of perfected carrier-rocket has placed into interim orbit a heavy artificial earth satellite and the Mars shot was accomplished from aboard this satellite.

The space rocket carries automatic interplanetary station "Mars-1", weighing 893.5 kg. The flight of automatic station to planet Mars will last over seven months.

The main problems in the launching of automatic station "Mars-1" are the following:

- prolonged space research during the flight to planet Mars;
- establishment of interplanetary space communication;
- shots of planet Mars with subsequent transmissions of pictures, taken of the Mars surface to earth radio-channels.

The cut-in of telemetric, measuring and scientific equipment is automatic in accordance with the flight program and on radio-commands from earth.

The tracking of the automatic station, parameters determination of its path, reception on earth of scientific information are done by the special measuring set up and by the center of distant space communications.

Preliminary results of measuring data processing at coordination center show, that the automatic station "Mars-1" moves along the calculated trajectory. On the 2nd of November at 10 hrs Moscow time the station will be 237 thousand km from the earth above a point on the earth surface with coordinates 37°W and 48°N.

The whole equipment aboard the automatic station"Mars-1" operates normally.

The launching of the automatic interplanetary station "Mars-1" is another step in space research and the study of solar system planets.

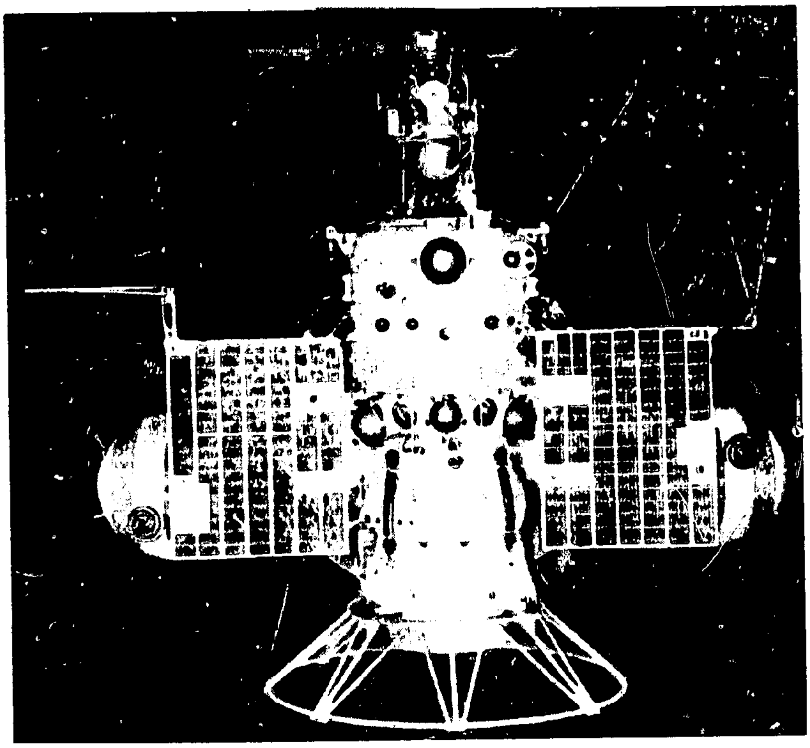

Figure 5. Automatic interplanetary station "Mars-1" on [illegible] support.

"Pravda", 2nd November 1962.

[illegible]

On the first of November 1962 an automatic interplanetary station "Mars-1" was launched in the Soviet Union toward the planet Mars. The new Soviet technological breakthrough considerably extends the world possibilities for [illegible] of the outer space and planets of the solar system.

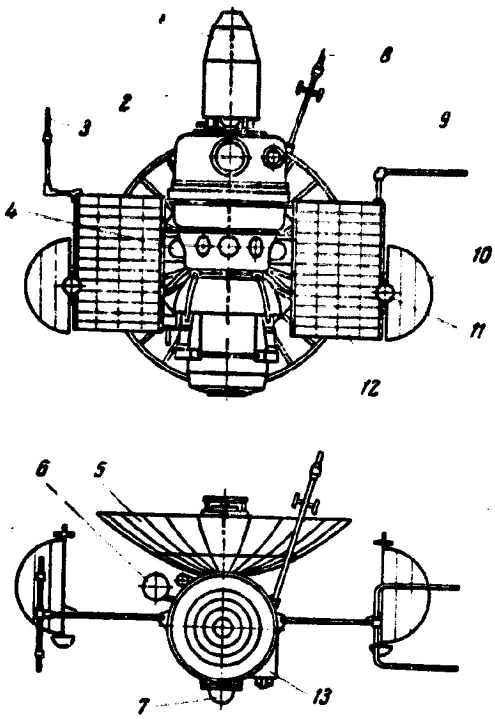

Figure 6. Diagram of the station's arrangement.

1- correcting propulsion system;
2- orbital compartment;
3- omnidirectional antenna;
4- **balloons** of orientation system;
5- pencil beam antenna;
6- spectroreflexometer;
7- precise stellar and solar orientation sensor;
8- magnetometer spike;
9- omnidirectional antenna;
10- radiators of tehermal control system;
11- low-radiation antenna;
12- solar battery panels;
13- constant solar orientation sensor.

The flights of space vehicles to planets of the solar system and the close to them Mars and Venus is enormously difficult problem. Its resolution involves working out a hole series of principally new problems, such as insertion into flight path of a space vehicle of considerable weight, construction of equipment capable of operating reliably for a long time in space, establishing space radio-communication at a distance of tens and hundreds of million km, perfecting and testing multistage carrier-rocket, working out of new principles for placing space vehicles into interplanetary paths, building of radio and scientific equipment, conducting extensive experimental work in conditions, similar to those of space.

Scientific Space Research

At present due to the launching of artificial earth satellites and space rockets it has been fixed, what effect magnetic field of earth has on the physical properties of circumterrestrial space. It was found, that the earth is surrounded by several radiation belts, consisting of particles captured by its magnetic field. It has been made clear, that the effect of the earth's magnetic field extends to tens of earth radii. This discovery is a principally new fact in the study of the planet of solar system and the space surrounding them. Actually, the physical properties of the space in the vicinity of celestial bodies with magnetic field, would appreciably differ from the physical properties of the outer space in the vicinity of celestial bodies not having a magnetic field. Moreover, in the outer space for from celestial bodies, may exist magnetic fields of various types due to magnetism of the sun, stars and flux of charged paticles, coming from the sun.

Elucidation of the existence of cosmic bodies magnetic fields have direct relationship to solving the origin and nature of the constant matnetic field of earth. In spite of the efforts of many outstanding physicists, astrophysicists and geophysicists, the origin of the earth's magnetism upto now could not be explained. There are many hypotehses, but not one of them is generally recognized. If we proceed from the theory, explaining the earth's magnetism by electric currents supposedly flowing inside the metallic fluid earth core, it is possible to fix the intensity of magnetic field on other planets, for instance, on Mars and Venus.

It is possible, that both the planets do have magnetic field, weaker than the earth. The knowledge of the magnetism of other planets taking into account their physical state will assist in making a selection between the existing numerous theories. It is also important in another respect. Knowing that one or another planet has a magnetic field, we can assert that there are phenomena existing on this planet, which could not have been on earth, if the field did not exist. In particular if Mars has a magnetic field, then it is surrounded, just as the earth, by a radiation belt. Besides the fact itself of magnetic field existance on the planet, it is important to know what is its intensity and now the magnetic poles are arranged in respect of the planet's rotation axis.

Magnetic fields existing in the circumsolar space affect also the propagation of cosmic rays, penetrating within the limits of the solar system. It is well knonw, that in the primary(not distorted by the earth atmosphere) cosmic rays there are no low-energy particles. This is known as high-latitude shearing of cosmic rays sepctrum, the nature of which is not yet finally fixed. Most probably it is specified by magnetic fields, which are carried away by corpuscular streams of the sun. It is possible, however, that some role is being played also by the constantly existing magnetic field of th solar system. In any case it is important to fix the distance from the sun, at which occurs the shearing of cosmic rays spectrum.

It could be expected, that intensity of cosmic rays does not remain invariable with the changing distance from the sun. With withdrawl from the sun the minimum energy of cosmic rays should drop, and the number of recordable particles increases. It is most essential to determine the dependence of cosmic rays intensity on the distance to the sun for various groups of nuclei, composing the primary cosmic radiation. If the shearing of cosmic rays in energy is not due to magnetic fields, but to some other causes, the intensity will, apparently, differ for different groups of nuclei.

To study mechanism of production of nuclei it is most important to carry out simultaneous intensity measurements of various groups of nuclei during high-power chromospheric flares on the sun and comparison of these results with intensity measurements of protons. The study of cosmic rays and of the solar activity effect on cosmic rays, coming from the Galaxy, compose now a whole sphere of research, closely connected with the physics of the sun and interplanetary medium.

Among other problems, connected with the study of space and solar system planets, great interest presents the study of the sun's corpuscular radiation and of interplanetary plasma.

Getting deeper into the outer space, it is important to know, what is the density of meteoric matter? The answer to this question is not only of scientific, but also of practical significance for future flights of space vehicles.

Movement of the Automatic Interplanetary Station "Mars-1"

According to laws of celestial mechanics, for the body to move in orbit, different from the earth orbit, it should be brought out from the region, in which the earth attraction appreciably affects its flight (upto a distance of about 1 million km,) with velocity distinct from that of the earth's orbit with velocity of about 30 km per second.

Figure 7 shows orbits of space vehicles, corresponding to various velocities of their movement. Thus, a space vehicle, which is [illegible] from the attraction sphere of the earth with velocity in relation to the sun of not less than 33-34 km per second, i.e. overtaking the earth in its orbital movement by 3-4 km per second, may move in orbit reaching the Mars. Space vehicles, which came out from the attraction sphere with velocity 26-27 km per second, i.e. lagging from the earth by 3-4 km per second will fly in orbit, leading to venus. In the case, if with exit from the sphere of earth attraction the space vehicle begins to overtake the earth at velocity, exceeding the minimum required, it will reach the Mars orbit even by shorter way, than at minimum velocity. However, this requires high consumption of the rocket's fuel. And this will cause the need either for reducing the admissible weight of the space vehicle, or will make the flight generally impossible. Orbit, in which it is possible to reach Mars with the least consumption of the rocket's fuel, is known as energetically optimum.

In the choice of the orbit, close to optimum, the estimate should be made also of a number of factors, such as the inclination ofthe orbital plane of Mars to orbital plane of the earth, conditions of radio communication with the station, the most convenient passage of the station in the vecinity of planet for scientific research, etc. For the flight to Mars it was necessary to select the time, when the position of earth at the moment of the rocket's take off and of Mars at the moment of the station's flight toward it coincided respectively with the start and end of optimum orbit. Thereby are determined the best dates of the rocket's take off to Mars.

Launching prior to and after this time involves high consumption of fuel.

The optimum dates for the flight to Mars follow each other approximately after 25 months. In 1962 this period has fallen to end of October - beginning of November.

This therefore, explains, that precisely on the 1st of November the blast-off was implemented of the high-power multistage carrier-rocket, aboard which was the controlable space rocket with automatic interplanetary station. The carrier-rocket moved with high precision along the prescribed trajectory. When the flight velocity reached the orbital velocity there was separation from the rocket of the satellite, which carried space rocket with the automatic station. The takeoff of the space rocket from the satellite took place at prescribed point of the orbit. When the flight velocity of this rocket exceeded that of satellite by about 4 km per second, and the rocket exited into prescribed point of the outer space, its motor was switched off. At this moment the station separated from the rocket and its free flight began on the path to planet Mars.

The earth's attraction retarded the station's flight. With exit from the sphere of earth attraction at a distance of about one million km the station was withdrawing from the earth at velocity of 3.94 km per second.

Energy consumption for insertion of rocket into interplanetary orbit depends also on the geographical position of thetake off point

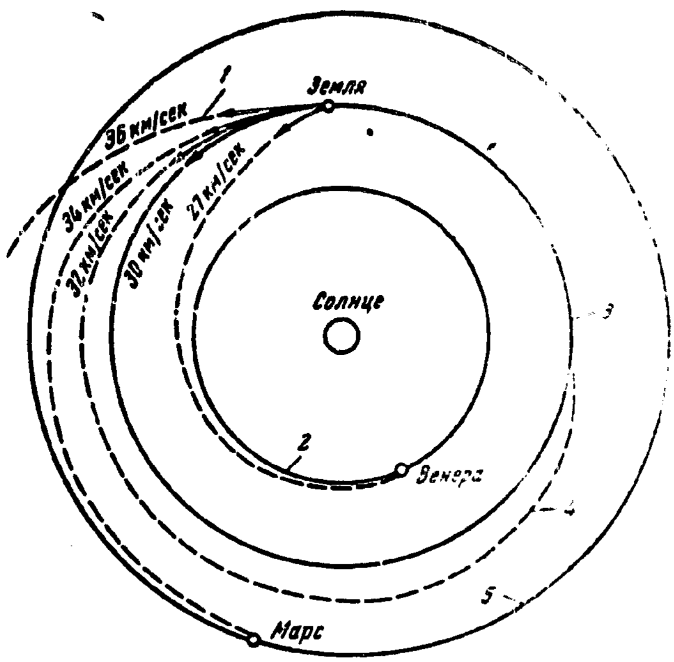

Figure 7. Flight of the Soviet interplanetary station "Mars-1".

1- non-optimum in energy orbit;
2- Venus orbit;
3- Earth orbit;
4- orbit of artificial planet, no reaching Mars;
5- Mars orbot

The new principle of launching the space rocket from the orbit of artificial earth satellite enabled to select for take-off from the interim orbit and optimum point. This made it possible to reduce demands on the energetics of the space rocket engines and to increase considerably the weight of the station.

Similar system of placing space vehicles for the flight to solar system planets was tested in 1961, as a result of which on the 12th of February 1961 a Soviet automatic interplanetary station was launched on the path to venus. This required a high-power multistage carrier-rocket with high-precision control system not only in propulsion branch of the flight, but even during the orbiting of earth by the satellite, aboard which was the space rocket with the automatic station.

The most difficult part in the working out of this system for insertion is the starting of the space rocket engines at exactly determined time in conditions of weightlessness, stabilization and orientation of rocket during operation of its engine. All this required resolution for the first time of numerous and difficult problems, many of which could be resolved on earth only theoretically. The corrections of these scientific assumption was checked directly during the flights to venus and Mars.

In spite of certain technical difficulties, the adopted system of placing automatic stations into interplanetary paths provides considerable energy gain in the launching of space vehicles of considerable weight.

Let's analyse the movement of the station after separation from the space rocket. Initially it takes place under the effect of attraction forces of earth, sun and the planets. Moreover upto distances of about one million km the predominant force is the attraction of the earth. Hence the flight of the station is affected mainly by the attraction force of the sun, and it moves in accordance with the same laws, as the planets of the solar system.

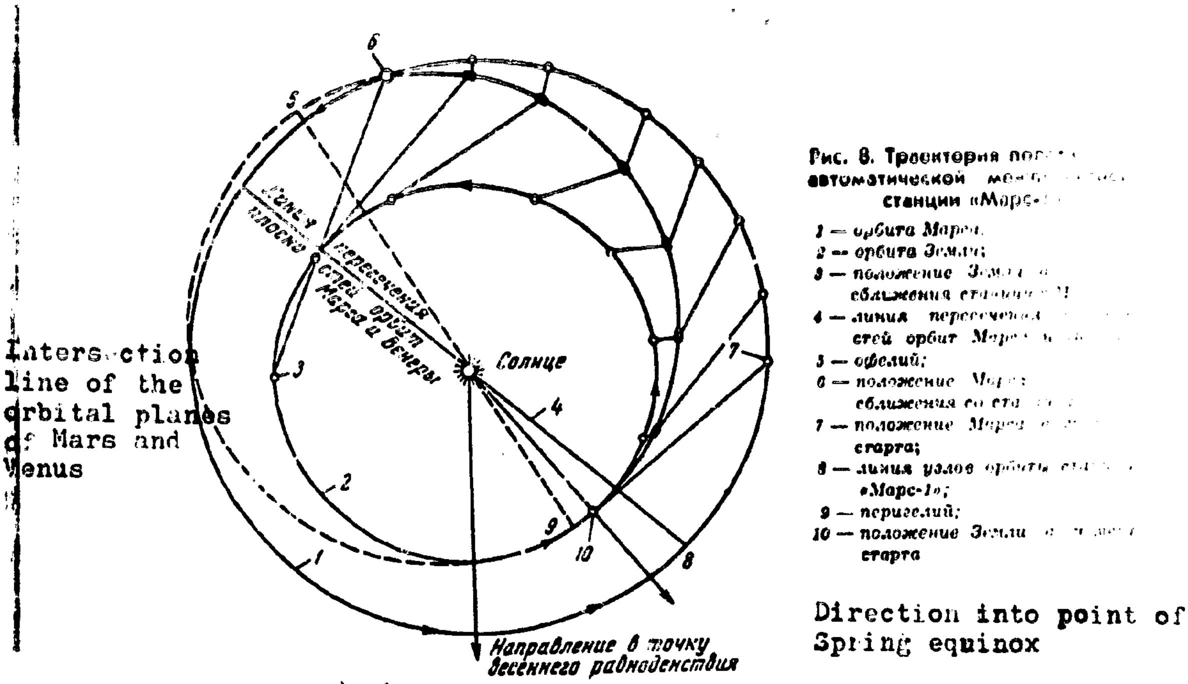

Figure 8. Flight trajectory of AIS "Mars-1".

1- Mars orbit;
2- Earth orbit;
3- position of earth at the meoment of the station's approach to Mars;
4- intersection line of Mars and earth orbital planes;
5- ophelium;
6- position of Mars at the moment of the station's approach;
7- position of Mars at the moment of take off;
8- line of orbital nodes of the station "Mars-1";
9- perihelium;
10- position of earth at the moment of take off.

The orbital plane inclination of the syation to the orbital plane of the earth is about $2^{\circ}37'$ and is very similar to the orbital plane inclination of Mars. In figure 8 the orbits of the station and Mars are projected on the orbital plane of the earth.

The simultaneous positions of the station, earth and Mars are joined by the straight lines. If the movement of the station and Mars is analysed in the plane of the earth orbit, its flight would have proceeded in the following way. Initially the station's velocity in relation to the sun exceeds the velocity of earth and is similar to it in direction. Therefore it overtakes the earth in the motion around the sun, simultaneously receding from it. Therewith in accordance with laws of celestial mechanics the velocity of the station will decrease. Therefore, the earth will come up with, and then overtake the station in its orbital flight around the sun. At the end of 1962 - beginning of 1963 the earth will be between the station and the sun, i.e. there will occur the so called opposition of the station with the sun. At this time the angle between directions from the station to earth and to the sun will become minimum - about 15 degrees. At the moment of approach to Mars the station will be at a distance from earth of 247 million km.

But if we analyze the movement of the station from earth in celestial sphere against the background of motionless stars, it can be seen, that it is irregular: initially faster, and then slower. The slowing down is explained by the fact, that the movement of the station in relation to earth after launching is almost radial. For some days after the take off the station was within the constellation Lynx. Then it passed into

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constellation Capella. Here the direction of its visible movement h s changed. Later on it intersects constellations Gemini and Castor and in the constellation Leo will approach Mars.

For the interplanetary station to pass close enough to the surface of Mars, an extremely high accuracy should be provided in placing the space rocket onto calculated trajectory. Thus, errors in velocity of space rocket only of 30 cm per second or errors in direction of velocity of one angular minute will result in increasing distance of trajectory from Mars by 20 thousand km.

Estimate of the station's movement from trajectory measurements data shows, that it will pass at a distance of 193 thousand km from Mars. This proves the high accuracy of the station's insertion into prescribed trajectory. To ensure the flight of the station at a closer distance from Mars requires correction of its trajectory.

Arrangement of the Station "Mars-1"

The automatic interplanetary station "Mars-1" represents two pressurized compartments: orbital and planetary. The orbital compartment contains equipment for the station's operation on the flight to Mars, planetary - scientific instruments, operating at the planet. On the orbital compartment is the correcting propulsion system, panels of solar batteries, semispherical radiators of the thermal control system and antennas.

Maximum dimensions of the station - 3300 mm in length 1100 mm in diameter of orbital compartment and 4000 mm in width, taking into account the solar batteries and radiators.

Weight of the station - 893.5 kg.

On the initial brnach of the carrier-rocket flight the station is covered with a radome,thrown off after the exit from the dense atmospheric layers. To place the station under the radome, the solar batteries, radiators and antennas are folded. After the station's separation from the last stage all the elements open out and take up working position.

The station is equipped with radio-technical devices, orientation and trajectory correction system, sources of power supply. The rajectory measurements and transmission of telemetric information to earth are done by means of the station's radio-systems. Operation of the airborne equipment is controlled automatically,aswell as by commands by radio-lines from the ground centers.

The orientation system is meant for stabilizing the station after its separation from the space rocket. It also provided for constant direction of the solar batteries on the sun throughout the flight, prescribed position of the station prior to cut-in of correcting engine. Optical sensors are used for the orientation of the station, directed on the sun, prescribed star and planets.

The thermal conditions of the station are determined by the operation of the thermal control system. Each semispherical radiator is divided into two parts, in which there are various external covers, heated by the sun to various temperatures. Inside the pressurized compartments of the station are heat-exchangers, into which depending on the station's temperature fluid is pumped from the cold and hot parts of the semispherical radiators.

The station carries instruments for the scientific research photo-television camera for taking shots of the Mars surface; spectro-reflexometer for detecting organic covers on the surface of the planet; spectrograph to study the absorption bands of ozone in the atmosphere of Mars; magnetometer for detecting magnetic field of Mars and measuring of magnetic fields in the outer space, gas-discharge and scintillation counters for defining radiation belts of Mars and the study of the spectrum of cosmic rays; counters for nuclear component study of cosmic radiation; radio-telescope for the study of cosmic radio-emission in wavelengths band 150 and 1500 meters; special sensors(traps) for recording low-energy protons and electrons, and also of positive ions concentration in the vicinity of Mars and in the outer space pickups for recording micrometers.

Telemetric information, received from aboard the automatic station during radio-communication sessions, confirmed, that the orientation system of solar batteries operates normally, providing recharging for the station's buffer batteries. The intensity of charging current is close to calculated one. Gas pressure inside the station is steadly maintained at about 850 mm of mercury. The measurements indicate, that normal temperature inside the station during the space flight became fixed within 20-30°C, temperature of construction elements confirmed the correctness of heat calculations and laboratory experiments, conducted prior to flight.

The communication sessions have shown, that the station is easily controlled on commands from earth. Passage of commands aboard the station and their implementation are efficient.

Airborne Radio-system and Ground Measuring Complex

Establishment of reliable radio-communication between the station "Mars-1" and earth at distance upto hundreds million km of space with limited electric power aboard is a significant technical achievement. In these conditions radio-telemetric systems should automatically form and transmit to earth without distortion code signals, containing information on behavior of construction and mechanism of the station (temperature, pressure, hermetization, solar batteris current, etc.), as well as information of scientific measurements. The command radio-line has the task to receive clearly and faultlessly the scores of commands fed from the earth, to decode them automatically, so that one or another of airborne devices could be cut-in consecutively. The trajectory-measuring system of the station in orbit, receiving inquiry signal from the ground centers and transmitting the answering radio-signal, must make it possible for the ground centers to measure distance to the station, its velocity and angular coordinates (direction).

The station carries three radio-systems, operating on waves in meter (1.6 m), decimeter (32 cm) and centimeter (5 and 8 cm) b nds. For transmission of telemetric information there are several commutators aboa d the station, which during radio-communication with earth cut-in by turn to transmitter, scientific equipment and pickups, recording the state of the station. The memory units fix the reading of scientific instruments, operating in the interval between the sessions, and transmit the information to the earth during the radio-sessions.

Radio-set of the meter wave band besides the transmission of telemetric information on the state of the station, serves also for maintaining communication with earth in the case of anomalous performance of orientation system.

At the initial branch of the station's flight to Mars the ground radio-technical facilities at centers of near-earth branch came into action. They conducted two-way radio-communication with AIS, carried out measurements of its radial velocity and distance and received telemetric information, characterizing performance of all its systems and units, and information from scientific instruments aboard.

The telemetric information is fed automatically along the communication lines into coordination center, where on quick-acting computers it is processed and analysed, the trajectory of the station's flight is determined.

For trajectory measurements the use was made also of the powerful telescope at the Crimean astrophysical observatory. By means of this telescope night shots were made of the space rocket and AIS against the background of the starry sky.

The results of radio-technical and optical trajectory measurements enable to calculate exactly the flight path parameters of the AIS and data of target destination for antenna systems at the center of distant space communication.

Operation of the Station in Flight during the Past Period

Communication sessions with the station were both automatic and on commands from earth. Operation program of airborne systems provides for automatic sessions at intervals of two, five and fifteen days. Selection of interval between the session is carried out on command radio-line from the earth. Intervals between the sessions are necessary, firstly so, that the solar battery could charge the chemical buffer battery, the energy of which is consumed during the sessions, secondly, so that the radio-session is at the moment of the best radio-visibility of the station which is repeated daily, due to the earth's rotation about its axis.

Till the 13th of December of this year the station operated in conditions of regular two-day sessions, and at present at five-days intervals. Every session begins with reception of telemetric information, containing results of scientific determinations and data on the state of the station, measurements of its velocity and distance. Thereafter on commands from earth memory unit is cut-in for reproduction of the earlier obtained information. The session is terminated by reception of telemetric information on the state of the station at the end of operation. Radio-sessions, which were conducted, indicate normal performance of all the airborne systems of the station. During the month since the take off of the station 37 sessions were conducted, over 600 commands transmitted, many hundreds of meters of telemetric tape with information were received.

Operation control of airborne equipment of the station throughout the flight indicates efficient performance of all the units and systems of command and computing centers.

Data were obtained during the radio-sessions with the station on interplanetary medium, radiation and fields in the outer space at distance of up to 6-8 millions km from the earth.

In the vicinity of the earth and in the circumterrestrial space new data were obtained on charged particles distribution in the so called geocorona - plasma sheath of the earth, beams were recorded of corpuscles coming from the sun.

Thus, on the 30th of November, according to preliminary data, a case was recorded of exceptionally high-intensity beam of solar corpuscles with over 800 millions particles per square cm per second. Intensity was measured of radiation in the area of the earth's radiation zones, and also background intensity of cosmic radiation with great withdrawl into space. It was found, that since the flight of the Soviet lunics the the background intensity of cosmic radiation has increased approximately by 50 - 70%. This increment is, apparently connected with the fact, that observations at the station are being conducted during a different period of the solar activity cycle. Far from the earth variations were recorded of magnetic field intensity of about 4 -12 gammas(gamma is the measurement unit of magnetic field intensity).

During the sgation's flight in circumterrestrial space repeated impacts were recorded of micrometeors. After the exit of the station to a considerable distance the number of impacts sharply decreased, which points to extremely low density of meteorite substance far from the earth.

Information, received from aboard the station "Mars-1", is being processed and will be published in scientific journals.

"Pravda", 15th December 1962. (TASS)

TASS COMMUNIQUE ON THE LAUNCHING OF AUTOMATIC STATION "ZOND-1"

On the 2nd of April 1964 an experimental launching was carried out in the Soviet Union of a multistage carrier-rocket with automatic station "Zond-1"with the object of testing space systems for distant interplanetary flights.

The last stage of the perfected carrier-rocket inserted into interim orbit a heavy artificial earth satellite, thereafter at a prescribed point space rocket took off from aboard the satellite and after imparting escape velocity to station "Zond-1" placed it into flight path close to calculated one.

The cut-in of airborne equipment of the station"Zond-1" is automatic in accordance with the flight program, and on radio-commands, fed from the earth.

Several communication sessions were conducted with the station "Zond-1".

Tracking of the automatic station and parameters determination of its trajectory are being conducted by a special complex on the territory of the Soviet Union.

The coordination center is processing the incoming information.

"Pravda", 3rd April 1964.

TASS COMMUNIQUE ON THE LAUNCHING OF AUTOMATIC STATION "ZOND-2"

In accordance with the program of space research the Soviet Union has launched on the 30th November 1964 a multistage carrier-rocket with automatic station "Zond-2" in direction of planet Mars.

The last stage of the carrier-rocket placed into interim orbit a heavy artificial earth satellite, then at a calculated time there was a take off from the satellite of space rocket, which imparted to "Zond-2", the velocity , required for insertion into flight path toward the planet Mars.

The object of the shot is the testing of the station's systems in actual conditions of a prolonged space flight and accumulation of practical experience. Simultaneously scientific research is being conducted in the interplanetary space.

Flight control of the station, parameter determination of its trajectory and reception of information is being conducted by a special command and measuring complex.

Communication sessions have been conducted with the station "Zond-2", during which data were obtained on the flight path of the station and the functioning of airborne systems. In accordance with the telemetry data, obtained during the first communication sessions, the power supply aboard the station is approximately half of the expected one.

The movement of the station, according to preliminary data, is along a path close to calcuated one. At 20 hrs Moscow time on the 30th of November the station was 40 thousand km from the earth above a point of earth surface with coordinates 156°09' E and 12°50' N.

The coordination center is processing the incoming information.

"Pravda", 2nd December 1964.

PLASMA JETS

The Soviet automatic station "Zond-2" has added another illustrious page in the chronicle of space achievements. For the first time a successful test was conducted aboard a space vehicle of plasma jets.

At a great distance from earth on command from cotrol center the orientation system was changed over to plasma jets, which operated in accordance with signals, coming in from the logical blocks of the orientation system. Six jets fitted on the system, maintained for a long time the required position of the station in respect of the sun. Now the efficient construction of plasma jet in conditions of space is practically proved. Thus for the first time in the world plasma began its operation in space. This is an event of very high significance.

But before we speak about this an attempt should,apparently, be made to explain the action principle of the plasma jet.

Although the plasma has become widely known only during the last decade (specially after the work has begun on thermonuclear synthesis), your encounters with this state of substance are much more frequent, than you may think. For instance, the flame of an ordinary match is a low-temperature plasma. In the intricate lights of neon advertisements shines the plasma of gas discharge. A light beam in the darkened hall of a cinema is thrown by a plasma cord, burning between two carbon electrodes. Golden disc of the sun, lights of electric welding, stars in the night sky. Everywhere we are dealing with the fourth state of matter - plasma.

Generally plasma is a gaseous mixture of negatively charged particles - electrons, positively charged particles - ions (atoms, which are devoid of one or several electrons) and neutral atoms. Plasma could be "cold" and "hot", with temperature from thousands of degrees to hundreds of millions degrees. In hot plasma there are already no neutral atoms. Although the plasma contains charged particles, it is on the whole electrically neutral: it has an equal amount of positive and negative charges.

The presence of free electrons makes it a good current conductor. This is the property that can be used for construction of electromagnetic plasma jets.

It is well known, that conductor with current in magnetic field begins to move in accordance with laws, familiar to all since the school times. This is precisely the principle, on which operate all electric motors. If the plasma is placed into magnetic field and current is passed through, the froce will begin to be applied and it will be accelerated. The flow into space of this acceletated to high velocity plasma will build up exhaust thrust.

This is one of the possible types of plasma jets.

In other schemes the use is made of high-temperature plasma. High-power electric arcs give considerably higher temperatures, than any chemical reaction. If "power gas" is heated in the flame of such an arc and blown-out through jet nozzle, it is possible to obtain exhaust velocities considerably higher, than in rockets, operating on chemical fuel. High exhaust velocities of producing body is the basic advantage of electric motors.

The thrust magnitude is determined by the product of a mass of exhausted matter by its exit velocity. To blow-out a lot of fuel, but with low velocity, or less with high- the "output" will be the same. It is natural therefore, that engine with high exhaust velocity of matter is more gainful. Due to reduced quantity of fuel the effective load could be increased. Unfortunately, chemical reactions energy does not permeate to accelerate the producing body more than four km per second. But for plasma jets this limit is considerably higher. Let us say, electromagnetic motors could produce exhaust velocity over hundred km per second. True, it is beyond the power of these motors to overcome the earth attraction, they could not take off the rocket from the earth. But in the "open space" their use has good prospects.

The power supply of these motors could be taken in space directly from the solar batteries or from some special source. The thrust of plasma jet can be easily adjusted within a wide range by varying parameters of its electric power supply. These motors could work for quite a long time.

On "Zond-2" the plasma jets were used in the orientation system, which is of vital importance for any modern space vehicle. Throughout the multimillion way to distant planets the orientation system must maintain the prescribed attitude of vehicle or to change it in a certain way, if there is the need. It should, for instance, watch, that maximum energy of the sun would fall on the semiconductor panels of solar batteries, in other words, that they are always perpendicular to solar rays.

Orientation system directs on the earth the station's antenna during the communication session.

Assuming, it was defined, that the automatic station has deviated from the course. In this case the orientation system must turn the vehicle toward the designation point, so as to cut-in the motors of correction system and to rectify the error.

As you see, "the sphere of duties" of the plasma jets in the orientation system alone is quite extensive. But this is far from exhausting their possibilities. Plasma jets could be used for the transfer of satellites from one orbit into another, for different maneuvring in assembly of circumterrestrial space stations. Finally, they could serve also as "sustainer" for multistage interplanetary rockets. It is possible, that interplanetary freight liners of the future will be precisely of this type.

The use aboard the "Zond-2" is made of only the first baptism of the plasma jets, they have only just left the laboratory cradle. But even now it is clear, that these new space settlers have a brilliant future.

Narrated by M.Millonscshikov,
Vice-president of the Academy of
Sciences, USSR

"Pravda", 20th December 1964.

TASS COMMUNIQUE ON THE LAUNCHING OF AUTOMATIC STATION "ZOND-3"

In accordance with the program of space research the Soviet Union on the 18th of July 1965 has launched a multistage carrier-rocekt with automatic station "Zond-3".

The last stage of the carrier-rocket inserted into interim orbit a heavy earth satellite. Then at prescribed time a space rocket took off from the satellite, which imparted to "Zond-3" the velocity, required for insertion into heliocentric orbit.

The object of the launching is the testing of the station's system in actual conditions of a prolonged space flight and sceientific research in the interplanetary space.

The flight control of the automatic station, trajectory parameters determination and reception of information are being conducted by a special command and measuring complex.

Communication sessions were held with the station "Zond-3", during which parameters were obtained of the station's flight path and data on the operation of airborne systems. The connection with "Zond-3" is quite stable. According to telemetry data all systems and scientific instruments operate normally. According to preliminary data the movement of the station is along a path, close to the calculated one.

The coordination center is processing the incoming information.

"Pravda", 19th July 1965.

TASS COMMUNIQUE. "ZOND-3" TOOK A SHOT OF THE OTHER SIDE OF THE MOON

The automatic station "Zond-3" continues its flight along the heliocentric orbit.

(

In accordance with the program working and testing is being conducted during the flight of various airborne systems in the actual conditions of a long flight and physical properties investigation of a distant outer space.

Besides the scientific instruments there is alos photographic equipment aboard the station for taking pictures in the space and transmitting them to earth at great distances.

For this prupose the station has a photo-television camera and transmitting radiosystem with a parabolic antenna (pencil beam antenaa), operating in a cm band. During communication this antenna is directed on earth with high precision by means of orientation system.

Transmission of picture, as well as the control of other equipment is implemented along the command radio-line.

With the object of testing photo-TV camera and radio-channels of picture transmission the flight path was selected so, as to pass in the direct vicinity of the moon, which made it possible at the same time to take shots of its surface.

The photographing of the moon began on the 20th of July, 1.5 days after the take off at 4 hrs 24 min Moscow time, when the station "Zond-3", was at 1160 km from the lunar surface, and completed at 5 hrs 32 min at a distance of about 10 thousand km.

After passing the moon the station continues its movement along the heliocentric orbit, receding from the earth and the sun.

The transmission of picture begun in accordance with the program on the 29th of July from a distance of 2.2 million km, when the angular dimensions of the earth became sufficiently small for the accurate guidance of the airborne parabolic antenna to earth.

From the station "Zond-3" pictures were taken off of the part of other side of the moon, which was not covered during the survey, carried out from the first time by the Soviet AIS in October 1959.

At the start of photographing the moon phase, visible from "Zond-3" it was alsmost fulmoon, and at the end of photographing almost half of the lunar disc was in the shadow. The initial frames covered considerable portion of the moon, visible from the earth. Subsequent frames give lunar surface with side-lighting by the sun, when the relief formations throw-off clearly visible shadows.

The pictures are transmitted from aboard "Zond-3" with clearness of 1100 lines. In photographing from a distance of anout 10 thousand km the pictures are obtained of lunar surface about 5 million sq, km in area.

The quality of obtained shots makes it possible to see numerous details of the lunar relief, which is of great interest.

The shots, obtained from aboard the station "Zond-3", will be published in central newspapers and in science editions.

For the analysis of obtained results and the naming of craters, ranges and other formations on the new part of the lunar surface special commission was formed by Academy of Science USSR.

The scientific research is being continued on the station "Zond-3".

For ruther tests of the radio-line picture transmission of the other side of the moon from aboard the station will continue during the subsequent communication session upto ultimate distances from the earth.

There are 38 communication sessions with the station "Zond-3"

All the airborne systems function normally.

At 10 hrs Moscow time on the 14th of August the station "Zond-3" was set a distance of 5 million 340 thousand km from the earth.

"Pravda", 15th August 1965.

MAJOR VICTORY OF SOVIET SCIENCE

New Data about the Other Side of the Moon

Almost eight yeafs have passed since Soviet Union, by the launching of the first artificial earth satellite, have initiated the mastering of the outer space. Numbers satellites are revolving in circumterrestrial orbits, providing valuable scientific data, and the space rockets penetrate far into the solar system, bringing new data on its structure. We are witnessing an impetous development of cosmonautics - from the first space flight of Yu.A.Gagarin to first exit of a man from the space cabin into the outer space, accomplished during the flight of spaceship "Voskhod-2" with a crew, composed of P.I. Belyaev and A.A. Leonov.

An important step on the way to other planets was the first flight on the path earth moon. It was accomplished in 1959 by a Soviet space rocket, which delivered to our natural satellite a pennant with the state emblem of USSR and enabled to obtain new valuable scientific data about the moon. After that several more earth vehicles reached to the lunar surface. One need not doubt, that during the next few years space rockets will permit to uncover new secrets of our natural satellite.

What is waiting for the future brave travellers there, on the other celestial body? What shall we meet in the strange world of the moon?

A lot of information about it was possible to obtain at the ground observatories. With improvement of telescopes and devices data obtained by their help, in spite of the earth atmosphere interference, were becoming progressively more diverse. The separation of 400,000 km could not prevent for instance, measuring temperature of the lunar surface. It was found that at lunar noon the temperature at the equator is up to 110-120° above zero, whereas at lunar night it drops to 150-160° below zero. Craters were discovered, the bases of which were warmer than the supporting surface, the characteristics became known of light reflection from different details, etc.

For many centuries sepcially great attention was paid to topography of the lunar surface. Hundreds of thousands of its details were discovered by visual and photographic observations. The most characteristic details of the lunar surface are the ring-shaped hills, craters and extensive dark depressions, traditionally called seas, although it is known long, that there is no water in them. In opposition to the "seas" the light hilly areas were named "continents". Now detailed large-scale maps were compiled of the lunar surfce visible from earth. On good modern photographs, obtained from earth, it is possible to see objects with angular dimensions not less than 0.4-0.6 angular seconds. For details in the center of the visible disc this corresponds on the lunar surface to size of 700-1000 meters, and in other areas to objects of kilometers in size.

The theoretical resolving power of the modern telescopes, in which the diameter of mirrors is up to 5 m, would have permitted to photograph details even many times smaller. However, this is prevented by the errantry of the earth's atmosphere. The astronomical observatories in mountains have the advantage, that the densest, dusty and erratic layers of the atmosphe are below the telescopes. This improves to some extent the transmittance conditions, but does not always results in the greater"stability" of the picture. Therefore the photographic observations have to be supplemented by visual observations.

In contrast to photographic pla the human eye is capable of picking those few brief intervals, during which the atmosphere becomes "quiescent", and to remember the clear images, emerging in this case, of even a snall number of derails. The consciousness of observer gets fixed on good images and "forgets" the bad ones. Whereas the photoplate " remembers" both the good and the bad images. As a result the total picture is less clear. This is why in composing lunar maps the use is made both of the photographic and visual observations, although it takes thousand times greater time.

The space flights made it possible to pass on to a new stage in lunar research.

The automatic lunar station "Luna-3" in October of 1959 made it possible for the first time to obtain information on the structure of the other side of the moon.

On American vehicles "Ranger" in 1964-65 pictures were

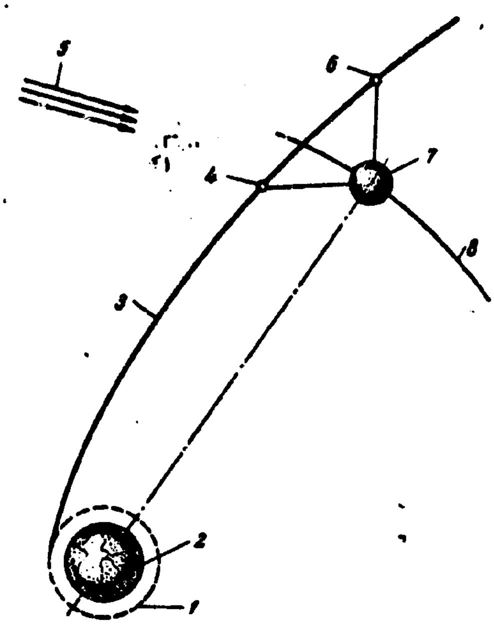

Figure 9. Movement diagram of "Zond-3" close to the moon during photographing

1- interim orbit;
2- earth planet;
3- trajectory of "Zond-3";
4- start of photographing;
5- direction of solar rays;
6- end of photographing;
7- planet moon;
8- moon orbit around the earth.

obtained of the areas on the visible side of the moon with considerably greater resolution, than it was attainable from the earth.

However, even now we know very little about the physical properties of lunar surface, such as the structure, hardness, chemical composition of the lunar soil. And this is of great significance for cosmogonic theories and future flights to the moon.

A number of new important data on the moon enabled to obtain application of radio-astronomical methods. For instance, these measurements lead to assumption, that at a depth of over one meter under the surface the temperature during the lunar day and night remains invariable. It was also detected, that fluctuation of heat radiation of the external layers are not in phase with the radiation of subsurface layers. It was possible, moreover, to determine the mean density of the lunar matter, data on its electromagnetic properties, to obtain other valuable information.

If the optical methods of investigation provided various information regarding visible side of the moon, the characteristics of its other side remained absolutely unknown. The scientists were forced to be satisfied with purely speculative hypotheses.

Some astronomers, for instance, suggesyed assumption of the difference of relief on both the sides of the moon, determined by the difference in their temperature conditions. During the lunar eclipses there is a sharp briefly-lasting changes of temperature only on the visible side of the moon. Whereas the other side of the surface is not subject to such sharp drops of temperature. Acting for many centuries, this effect it would seem, should have resulted in the difference of relief. But is it so?

This and many other hypotheses could be checked, only by the study of the other side of the moon. The problem consisted in the global investigation of our satellite - it was necessary to obtain information almost on a score of millions of square km, inaccessible to earth observers. In our time the possibility has appeared for implementing this task - by shooting to the moon of automatic interplanetary station, which would photograph its other side and transmit to earth by means of radio and TV the obtained pircures. This grandiose experiment required overcoming enormous differences. Exceptionally composite requirements were demanded not only of the station's equipment, but also toits flight path, power of rocket.

Soviet Union has made the start on the 7th of October 1959, when the automatic station "Luna-3" took shots of the other side of the moon and transmitted them to earth. The program was composed in a way, that the pictures would show also the eastern marginal zone, visible from earth. In this case a part of the other side of the moon remained not photographed. Identification on the photographs, transmitted from space, of about hundred details of the eastern marginal zone with the known coordinates provided for the typing in a single (with visible side) system of selenographic coordinates all of the 500 objects defined on the other side of the moon. Moreover the identified formations of the marginal zone served as samples for interpretation of the new details.

For the first time in the history of science TV pictures of another celestial body were transmitted to earth from the space. The results of their study were published in the Atlas of the other side of the moon, edited by the Academy of Science USSR, and in other editions.

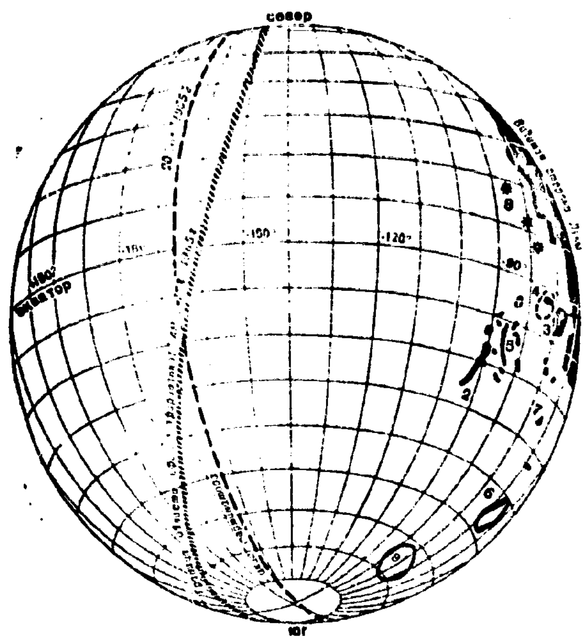

Figure 10. Arrangement diagram of the region, photographed by the automatic station "Zond-3".

On the basis of the map, composed for the first time of the other side of the moon and other Atlas material was issued a first globe of the Moon with the picture of its other side. Abroad transliations of the Atlas the glone were issued in Poland, England, USA, France and other countries. During the six years there was no photographing of the other side of the moon.

On the 18th of July 1965 the blast was made of the automatic station "zond-3" , meant for investigating physics of distant space working and testing of various airborne systems. In particular the station carries equipment for taking piactures of the planets and their transmission from distance up-to hundred of millions km.

After the take off from the earth satellite orbit with velocity, exceeding that of escape, moving along its beliocentric orbit, the station "zond-3" passed 33 hrs after take off in the vicinity of the moon. The photo-television equipment, available on board, was used to obtain pictures of lunar regions, remaining unknown until now. The photo-television set permits to transmit repeatedly each frame with decomposition into 1100 lines* and with clearness , equal to 860 elements along the line.

Since the TV equipment is estimated for transmission of frames from distances up-to hundreds of millions km, the transmission of one frame takes up 34 min.

The transmission of obtained pictures of the moon is in the cm band of radio-waves with the use of airborne pencil beam parabolic antenna. During the communication this antenna is directed on earth with high precision by means of the orientation

* We remind, that in the ordinary television the number of lines is 625.

system. The transmission of picture is determined by command from earth.

The picture taking continued for 1 hr 08 min. It began at a distance of 11.6 thousand km from the lunar surface and completed after passing at minimum distance (less than 10 thousand km). During picture-taking the position of "Zond-3" in relation to moon changed in longitude by 60°and in latitude by 12°.

The transmission to earth of obtained pictures begun on the 29th of July from a distance of 2,200,00 km from the earth, when the angle of visibility of the earth from the station became sufficiently small for exact guiding of the airborne antenna. In future these transmissions will be from considerably greater distances.

Disposition of trajectory in relation to the moon was selected in such a way that in the orientation of photo-television camera on the moon only those regions of the other side which are of the greatest interest will come in their field of vision.

The selection of the space station's distance to lunar surface and, on the other, to obtain it on quite a large scale. With the movement along the trajectory areas appeared in the vision field of the station of the other side of the moon, not photographed in 1959. The region of photographing extended to the boundary of the lit up part of the moon.

The morning terminator, that it the boundary of the light and dark parts of the lunar disc, was photographed on the 20th July 1965. It was the day of picture-taking the pictures obtained covered the area close to the edge of the other side which has already been photographed. Thereby the newly obtained pictures practically cover the previously unknown part of the lunar surface. Some pictures overlap with the visible side of the moon, and others - with picture of reverse side of the moon, taken in 1959.

During the picture-taking the sun was at the zenith above the northern edge of the crater sea, known as piccioli. Thus, in the less advantageous conditions of lighting were the known areas of the visible side of the moon, needed mainly for the general identification of the pictures. Whereas the majority of objects, located within the earlier unknown part of the other side, was lighted by the oblique sunrays, which most graphically define characteristics of relief.

The station"Zond-3" took pictures of the so called Easter Mare - the most typical formation on the eastern edge of the invisible hemisphere. As many other lunar seas, the latter has an oval shape and is bordered at a considerable extent by two mountain ranges cordilliera and Rooca, between which lie the dark trails of Autumn and Spring maria. Observable from the earth is only the edge of the

Eastern mare with its bays Big Rhomb and Minor Rhomb. Now it has became clear, that the spring mare in the north passes beyond the boundary of the visible side of the moon, and that the mountain ranges border the eastern mare on all sides.

South of the eastern mare are two previously unknown small maria, divided by a mountain range.

The attention is drawn to the similarity between the area of the eastern mare and lying opposite on the visible side Mare Crisium. Both the oval maria are surrounded by mountain ranges similar in structure and disposition among which are the ribbon-like maria: Foam, Waves and Serpent around the Mare Crisium and four above mentioned maria around the Mare Eastern. Adjacent to both the maria are very light continental areas.

Having at our disposal information on both the lunar hemispheres, it is possible to get an idea regarding distribution of dark "seas" and light "continents" of our satellite. Whereas the northern half of facing the earth hemisphere of the moon is taken up mainly by the seas, the northern part of the other side of the moon is taken up by gigantic continent. This continent is considerably larger than its antipod - the southern continent of the visible hemisphere. Whereas the continental space of the other side has extensive depressions, extremely broken up by superposed craters, resembling Deslanders region on the visible side. These formations 200-500 km in diameter are comparable in size with maria, but do not have the typical for them dark color and differ in structure.

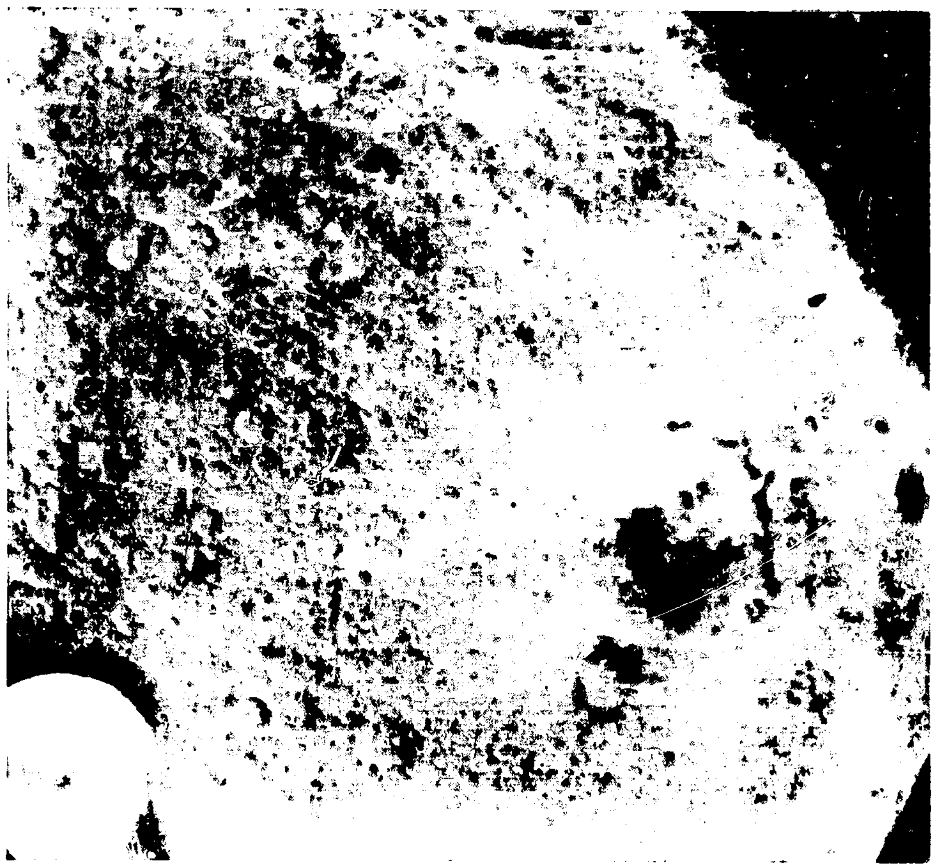

Figure 11. Picture of the other side of the moon, transmitted by the automatic interplanetary station "Zond-3".

The picture, taken on the 20th July 1965 at 5 hrs 16 min Moscow time, shows equatorial zone of the other side of the moon, adjacent to the eastern edge. The big dark spot on the right - Mars Eastern.

The amazing thing on the other side is the abundance of major craters, superposed one on the other (Fig.11 and 12). The total number of craters on the other side could be described by the following data. On a territory of about 5 million sq.km, covered only by one of the frames, there are 4 craters with diameter over 200 km, about 20 craters - from 100 to 200 km, 60 craters from 50 to 100 km, 100 craters - from 20 to 50 km and over 400 craters - from 10 to 20 km. The pictures clearly show typical for the moon craters with central peaks and craters with light rays.

The most interesting of the newly discovered formations, not seen on the lunar hemisphere visible from earth, are the numerous chains of minor craters extending to hundreds of km, diverging, apparently, from the light continental area in the vicinity of Eastern Mare, and also the previously mentioned enourmous mare-like formations on the continent (thalassoids).

After the careful processing of the 1959 photographs the conclusions were drawn about the asymmetry of the moon in related to plane, dividing it into visible and invisible parts: on the reverse side there are comparatively few maria and the whole of it is more light and more hilly. By the way there is similar asymmetry in the earth globe. Pacific ocean, the deepest parts of which are more than 10 km in depth, and the average depth is over 4 km, composes up to 50% of the total surface with water and is situated almost wholly in

Figure 12. Picture of the other side of the moon, transmitted by automatic interplanetary station "Zond-3".

The picture, aken on the 20th July 1965 at 5 hrs 25 min Moscow time, shows equatiorial and northern parts of the other side upto the liten up region.

the western hemisphere. Disposition density of craters on the other side of the moon was found to be higher, etc These conclusions are fully confirmed by the pictures of the station "Zond-3". At present the new pictures of the other side of the moon are being carefully studied and a preliminary catalog of formation is being compiled.

The material of experiment, conducted by "Zond-3" on photographing the moon, have an important scientific significance. The other side of the moon is no more a mystery.

Yu. Lipskii, Dr. of Physico-mathematical Sciences, Director of the moon and planets physics section at the Astronomical Shternberg Institute of the Moscow State University.

"Pravda", 17th August 1965.

SOVIET SCIENCE UNCOVERS SECTRETS OF THE UNIVERSE.

Press-conference at the Academy of Sciences USSR

Yesterday a press-conference was held in Moscow, on the launching of automatic interplanetary station "Zond-3" and taking the picture of the other side of the moon. The new major technological breakthrough caused great interest in Soviet and foreign correspondents. In the conference hall of the presidium of the Academy of Sciences USSR gathered numerous representatives of the major newspapers and telegraph agencies from the various countries. The press-confernece was addressed by scientists - astronomers and astrophysicists.

The press-conference was opened by M.V.Keldysh, President of Academy of Sciences USSR.

The First Step of Space Astronomy Address by M.V.Keldysh.

Only eight years have passed since the launching of the first artificial earth satellite, space vehicle, by means of which the mankind obtained the actual possibility for studying inaccessible regions of the world surrounding us. The horizons of science have immensely extended. Important information has been obtained on the physics of the outer space in the vicinity of Earth, on interplanetary medium, radiation of sun, physical properties of planets. Remarkable flights accomplished of manned spaceship satellites, which even more widens out our possibilities for cognisance of the mysteries of the Universe and flights to other planets.

An important step on the path were the first launching of the Soviet space rockets to the moon, nearest to us celestial body. Throughout many centuries the application for the study of the moon was of visual, photographic and other means, with the help of which it was possible to obtain detailed information on the part of lunar surface visible from earth. A more detailed study of the moon by photographic methods is prevented, as we know, by the earth's atmosphere, its instability and dust content. Therefore, the photographic methods are considerably supplemented by visual method. This profixed valuable information on the lunar relief, the most typical formations of which are the ring-shaped hills, craters, and also depressions known as maria, and the light areas, called the continents.

During the last decade a widespread application in the study of the physical properties of lunar surface have obtained radio-methods, which provided important data on density, structure and electromagnetism of the moon's upper layers. All these methods, enabling to study from earth the visible part of the lunar surface, are principally inapplicable for the study of its other side, which for many centuries remained a mystery. Most controversial hypotheses were put forward about the structure of the other side of the moon, which could not be checked by the available ground facilities. The space rockets opened a new stage not only in the study of the moon, but in the whole of the astronomical sciences, having armed it with powerful experimental methods.

In September 1959 was the blast- of of a space rocket with automatic station "Luna-2", which for the first time reached the surface of the moon. As a result of this flight it was fixed, that the moon does not have a noticeable magnetic field and radiation belt.

On the 7th of October 1959 automatic station "Luna-3" photographed for the first time the other side of the moon, and the obtained pictures were transmitted by TV to theearth. These were the first photographs of the other side of the moon, an information of enormous scientific significance.

The results of studying the obtained pictures were published in the Atlas of the other side of the moon, edited by the Academy of Sciences USSR. After the Soviet moon shots in 1964-65 there were flights of the American space vehicles "Ranger", as a result of which pictures were obtained of the visible side of the moon with high resolution of details on its surface.

On the 18th of July 1965 automatic station "Zond-3" was launched for scientific research in distant space, and also for resolving a number of problems, connected with the working of airborne systems of distant space vehicles.

The automatic station "Zond-3" is equipped with a large amount of scientific instruments for magenetic properties study of the circumterrestrial space and interplanetary medium, solar wind, low-frequency radio-emission of the Glaxy, micrometers, cosmic rays, as well as for the study of infrared and ultraviolet spectra of the lunar surface. A lot of scientific information has already been obtained, which is being processed. Besides the scientific research testing will be carried out of plasma jets, which are of significance for working out new facilities of orientation systmms and astro-correction, The material will be tested in conditions of the outer space.

The station carried photo-television camera for taking pictures of the planets and transmitting them from distance of hundreds of millions km.

The launching date of the station "Zond-3" and its flight path was aimed at obtaining and transmitting the pictures of a part of the other side of the moon which remained unphotographed in 1959.

The pictures were taken at distances of about 10 thousand km, and the TV transmissions were conducted with decomposition of frame into 1100 lines. The choice of conditions for the picture-taking and high resolution of the TV system made it possible to obtain very detailed and clear pictures of the other side of the moon, which are of great interest. In their quality the photographs transmitted from the automatic station "Zond-3", are not lagging behind the best pictures of the visible side of the moon, obtained in ground observatories.

The pictures, obtained by the automatic stations "Luna-3" and "Zond-3", have resolved many puzzles, connected with the other side of the moon. Now there are no "white" spots left on the other side of the moon.

The world astronomiers have received into their hands an abundant material, which has to be most carefully analyzed and studied. The space astronomy is making only the first steps, but even now it can be said, what powerful means in the shape of satellites and space rockets has the mankind been enriched for the further progress of astronomy, study of the solar system planets and future interplanetary communications.

The space vehicles will penetrate progressively further into the depths of the universe bringing new valuable information.

How the Shots Were Made

Professor A.I.Lebedinskii

The interplanetary automatic station "Zond-3" is now receding from the earth and the sun. Today at 12 noon it was at a distance of 7175 million km from the earth. "Zond-3" is an artificial circumsolar planet. With the maximum withdrawl from the sun it will pass close to Mars orbit, but the date of its launching was selected so,that there will be no approach to the Mars.

The main objects of the launching of "Zond-3" were the testing of the airborne equipment in conditions of prolonged flight and scientific research in the outer space. It was possible to combine this with picutre-taking of the still unexplored region of the other side of the moon, photographing of the lunar surface specra in the interval of wavelengths from 3500 to2500°A, spectrophotometry in the ultraviolet region from 2700 to 1900°A and in the infrared from 4 to 3 microns.

Soviet station "Luna-3", which on the 7th of October 1959 accomplished for the first time the phototelevision transmission from space, photographed only the eastern part of the other side of the moon with extent approximately 110° in longitude. About 70° in longitude remained until now a white spot on the lunar map. To be more precise, this white spot is limited by the lunar meridian from the visible side of the moon, and inthe region photographed earlier by a large circle, intersecting meridian on the equator at an angle of about 12°. Because of this the unexplored region is wider in the southern, than its northern part.

The selection of the flight path and the launching date of "Zond-3" was connected with the fact, that the maximum recession from the sun is obtained in the case, when the station's velocity in relation to earth adds up with the orbital velocity of the earth around the sun, i.e. when the station escapes into heliocentric orbit in direction "forward" according to the earth's movement. For the station to pass with this trajectory in the vicinity of moon, the launching date should be prior to the last moon quarter, which in July of this year was on the 21st at 20 hrs 54 min Moscow time.

The more exact selection of the flight path and the launching conditions in the investigation region of the moon. The fact is, that the most suitable conditions for picture-taking is with the low height of the sun above the horizon. Then the hills throw off shadow, from the length of which it is possible to determine their height, and the picture itself is clear and with examination seems almost raised. Therefore, the best pictures of the lunar surface are usually obtained in the vicinity of terminator, i.e. at the boundary between the illuminated and dark parts of the lunar disc. Naturally, for picture taking from "Zond-3" the time selected was, when the whole of the unexplored region was illuminated, and the terminator passes along its western edge. In this case the least suitable conditions for the shooting, when the sun was high above the horizon were found to be in an area of the visible side of the moon, photographed for the cartographic to know lunar obejcts.

The station "Zond-3" passed near the moon on the side of the sun. Its path passed south of the plane of the lunar equator, which made it possible to cover better the southern, wider part of the unexplored region. At the moment, when the shooting started the station was still above the visible side of the moon at 11.57 thousand km from its surface. The moon, visible from"Zond-3" was in phase of almost fulmoon, whereas from the earth at this time it was seen almost in the last quarter. In further movement the station passed to the other side of the moon, gradually approaching its surface to a minimum distance of 9.22 thousand km, thereafter beginning to recede from the moon at the end of the shootihg was already at a distance of 9.96 thousand km.

With the distance of the flight-past about 10 thousand km each picture covered a major part of the unexplored region. During the picutre-taking position of the "Zond-3" in relation to the center of the moon changed by about 60°, and every section of the unexplored region was shot at various angles, so to say, in various foreshortenings. This makes additional possibilities both in the analysis of surface relief and in the study of its reflective capacities.

The optical axes of spectral devices were directed parallel to optical axis of the camera, which provided for the ting of obtained spectra to locality. The results of spectroscopic investigations are being processed and will be published in scientific journals.

The Moon in the Objective of"Zond-3" Photocamera

By

Enginner Yu.K.Khodarev.

The automatic scientific station "Zond-3" besides resolving problems on the physical properties of the outer space, provides for working of systems and devices for distant space vehicles, including those for photographing and transmission of the pictures of planets.

At present quite developed are two main methods for obtaining pictures of planets by means of space vehicles. The first is television, in which the picture aboard the space vehicle is obtained during the flight past of the planet in the form of electric signals, recorded on magnetic tape from television tube. Reporduction of this recording takes place during transmission to earth.

The second method is photo-television, in which the picture of the planet at the moment of the flight past is obtained by photographing on the film, and the transmission of picture from the film is provided by phototelegraphy or television.

Both the systems have their advantages and shortcomings.

Phototelevision requires presence on board of equipment for developing and processing of the film. Moreover, as we know, the undeveloped photoemulsions are very sensitive to space radiation and cannot withstand prolonged time in space even with quite a massive screening.

However, the phototelevision system have their own advantages: firstly, the possibility of obtaining by relatively simple and reliable methods high number of frames with very clear picture and, secondly, the possibility to vary the clearness and standard of decomposition in transmission to earth in relation to working conditions.

These properties are very useful in working at interplanetary distances, since there is a possibility of transmission in accelerated conditions of a great number of frames with lower standard of clearness, and then after selection of the best ones the transmission is assured with high clearness.

As a result of work, conducted in the Soviet Union, a new small-size phototelevision system was constructed, meant for the taking and transmission of the picture of planets and for working in conditions of prolonged space flight. In this system reliable protection of the film the effect of space radiation has been fully resolved.

According to communique, the moon was photographed from aboard the station "Zond-3" on the 20th of July between 4 hrs 24 min Moscow time.

The command to start taking photographs was given from the earth at 3 hrs 57 min during the station's approach to the moon. All further operations were automatic without intervention from the earth. Immediately after the command the orientation system began the search for the moon and turning of the station in a way, so that the objective of the phototelevision camera would be directed to the illuminated part of the moon. Simultaneously the preliminary of operations began with the phototelevision equipment. After 14 minutes the tape recorder was switched and the rewinding begun.

The picture-taking of the . ·n began on the 28th minute and continued for over an hour. Automatic processing of the film was simultaneeus with photographing. The processed film was fed directly into the system for transmission in the form, suitable for transmission.

The moon was photographed at intervals between frames of about two and a quarter minutes. 25 shots of the lunar surface were obtained during photographing of the moon.

The number of frames was determined by the equipment for taking pictures of the planets, carried on the station "Zond-3". However, with the selected angle vision of the objective there was considerable recurrence of the lunar surface areas on adjacent frames and 25 pictures with the available clearness were more than enough to obtain the whole region, which was being photographed, with good resolution of details.

The photocamera of "Zond-3" used objective with focusing distance 106.4 mm with relative aperture 1:8. The pictures were taken on a special film 25 mm in width with exposure 1/100 and 1/300 seconds.

The pictures were transmitted during communications through pencil beam parabolic airborne antenna, estimated for operation at long distances.

The transmission time of one frame with clearness 1100 lines composes 34 minutes. This time was selected also on basis of working conditions at interplanetary distances.

The airborne apparatus of "Zond-3" made it possible to vary the transmission time of the frame and the clearness both for increment and decrement. In particular, the transmission of all the frames was implemented in conditions of quick review at low standard of decomposition at the rate of one frame per 2 min.15 sec. This made it possible to appraise the quality of all the frames and to decide, which of them were more interesting for the subject.

At present repeated picture transmissions are being conducted of the more interesting frames, taken from various points of the flight path. In future the transmission will be repeated from large distance.

Results of the Preliminary Investigations of the New Photographs

A.G.Masevich, Dr. of Physico-mathematical Sciences, Deputy-Chairman of the Astronomical Council of the Academy of Sciences USSR.

Allow me to introduce you to the preliminary study results of the new photographs of the other side of the moon. These results were obtained by a group of scientists of P.K.Shternberg State Astronomical Institute under the supervision of Prof. Yu.N.Lipskii.

The circumstances of photographing, selected for "Zond-3" as pointed out, are different from the conditions of photographing by "Luna-3". Then, six years ago, the experiment of photographing another celestial body and transmission of TV pictures to Earth was set up by Soviet Scientists for the first tiem in the history of mankind. An enormous territory has been photographed over 10 million sq.km, but one-third of the invisible hemisphere of the moon remained still unexplored after the photographing in 1959. This is the part, that has been photographed by the station "Zond-3".

The new photographs are of exceptionally high quality. The photo-television set aboard the station "Zond-3" assured not only the decomposition of each frame into 1100 lines, but also high photographic width. The photometric device(its picture on the shots are on the left bottom corner) permits to measure the brightness of the photographed lunar formations. The pictures clearly show the half-tone transmission which transmit characteristics in configuration of details. The photographs are quite comparable with shots of the visible side, obtained a modern astrographs of ground observatories. Now it is possible to define not only the existence of a great number of defails, but also to investigate the structural characteristics of the lunar surface. Thus, at present we have detailed information about practically the whole lunar surface.

First of all it should be mentioned, that the new photographs have fully confirmed the previous conclusion about the small number on the other side of the moon of the extended dark troughs, traditionally called maria. Whereas the northern part of facing the earth lunar hemisphere is covered mainly by maria, the northern part of the other side is taken up by a gignatic continent - i.e. light elevation, covered by craters. This continent is considerably larger in dimension than its antipode - the southern continent of the visible hemisphere.

An exceptional interest represent the mare-like formations, discovered on the other side, which should be called thalassoids. These are extensive depressions, the bottom of which are studded with craters. In their dimensions these depressions are comparable with mariatheir diameters are up-to 500 km. However their bottoms are different in structure and do not have the dark coloring typical for maria. On the visible side of the moon we do not meet so clearly expressed gignatic depressions. Similarly with some thalassoids shows the intensely broken desalnders crater, located close to well known radiant Tycho crater and, possibly, the largest of craters on the visible side Baily.

Soviet selenologist A.V.Khabakov repeatedly pointed out the unique depression, partially taken up by Mare Nectaris. It may be assumed, that this depression in the past was a gignatic thalassoid 1200 km in diameter, bordered by pyrenees and Altai mountains. A part of the thalassoid, flooded subsequently by lava, is the one known as the Mare Nectaris.

Even now, after the first statisticalevaluations, it is possible to state, that the previous conclusion about the high concentration of craters on the other side has been confirmed. Defined on the newly obtained photographs are over one thousand formations. In particular, on the surface of the other side of the moon, shown in pictures, over 600 craters are counted with diameter from 5 to 20 km, about 200 craters - from 20 to 50 km, about 40 craters - from 50 to 100 km and about ten craters over 100 km in diameter. The least distinguishable on the pictures craters have diameter of about 3 km. The investigated craters have on the whole typical fromthe moon.shape, moreover there are craters with central peaks and craters, which are centers of radial systems.

Exceptionally interesting are the chains of craters with considerable extent, not seen in the visible hemisphere. The chains are formed by craters of medium size 10-30 km in diameter. Some of the crater chains, diverging, apparently, from the light continental area north of Mare Eastern, extend for 600 km and more.

It is also important to mention, that the continental region, shown in photographs, is quite rich in half-tone shades, Thus, among the hilly light areas are individual dark spots, not connected with changes in the visible structure.

An individual mention should be made of the dark spot in the right bottom part of the pictures. A small portion of it was knwon from the observations from earth as the Mare Eastern. Now for the first time we can judge about the actual configuration of this formation. As already mentioned, in direct vicinity of this formation are the dark bands of the Mare Autumn and Mare of Spring. Now we can add to them the two dark formations, earlier not observed from the earth. Moreover, it should be mentioned, that the assumption, based on visual observations, about the existence south of Mare Easter of one more mare, provisionally named Shallow, is not confirmed by the new photographs.

Presence on the pictures of a great number of details, pertaining to the visible hemisphere, enabled to tie the new formations into a single selenographic system of co-ordinates.

Joint analysis of pictures of the other side of the moon, obtained in 1959 and now made by "Zond-3", confirms the conclusion about the asymmetry of the moon in relation to the plane dividing it into visible and invisible hemispheres; there are few maria on the other side, and it is all more light and hilly.

The newly obtained photographs have such a large volume of information, that their complete processing will require a very long time.

In conclusion on behalf of astronomiers, who are studying the moon and the planets, I thank the creators of the spaceship "Zond-3" - talented creaters of the Soviet space technique, Thanks to them we can say today: the other side of the moon has ceased to be a mystery.

Mankind has come Closer to Uncovering the Secrets of the Moon

A.A.Mikhailov, Academician.

Whereas on the visible hemisphere the so called maria, i.e. the darker and lower lying plains, cover about 40% of the surface, on the other side the area of maria is not even 10% of the surface. The new pictures, covering about a third of the other side area of the moon, which wasnot covered by the "Luna-3", fully confirmed this difference - there is not one mare in them of any extent.

There were attempts to explains this difference, which , it would seem, should be in some way connected with the earth and its effect on the visible side. The first thought was of the earth's gravity effect on the moon. But the tide-raising force originating due to this is similar in both the hemispheres up to a fraction of a per cent, and therefore there are two tidal rises: one on the side of attracting body, in this case the earth and the other, of almost the same magnitude - on the other side. Thus, the observed difference cannot be explaind by this.

Then it was pointed out, that lunar eclipses occur only on the visible side, when the earth's shadow falls on the moon and the temperature of the upper layers of its surface drops within an hour by more than hundred degrees. It would seem, that such rapid cooling could have caused breaking up of rocks on the moon. However, radio-observations have shown, that the surface layer of the moon has a very low heat conduction, similar to the best thermal insulation material. Even at a depth of a few decimeters the temperature during an eclips reamins constant.

Thus, the eclipse effect could have resulted in structural changes only of the upper most cover, and not in such great differences in the number of maria, which is a considerably deeper change in the structure of the lunar crust.

Finally, mention was made of the shielding effect of the earth in respect of meterorites, falling on the part of the lunar surface visible to us which is, apparently, absent for the other side. But there it should be mentioned, that the earth disc, visible from the moon, covers less than one seven-thousnadth part of the whole sky vault, out of every point of which there may be a shower of meteorites on the moon. Therefore, this shielding is insignificantly low. Moreover, the earth with its attraction bends the paths of meteorites, flying past the earth at quite a close distance, to the side, so to say, of the "earth shadow", which causes exactly opposite effect to shielding. Thus it seems to me, this reason may also be dismissed.

It would seem , that the matter here is not of the external effect, in particular of the earth, but of some internal causes. Even on the earth there is a sharply defined difference in its two hemispheres - of the eastern from the western. In the eastern hemisphere,where lie the big continents of Euroasia and Aftica, as well as of Australia, the whole 40% of the surface is taken up by land. Whereas in the western hemisphere the two Americas take up only20% of the whole area. While the fast rotation of the Globe about the six levels out all the external effects from the side of other bedies of the solar system, also the Glaxy as a whole. Therefore, the explanation should be sought for in the internal processes, pertaining to geology and geophysics, rather than to the sphere of astronomy.

And by the way, a few words about the meteorites. There are two parallel theories about the origing of the more notable formations on the moon - craters and ring-shaped hills, or cirques. One theory attributes their origin to the falling of gignatic meteorites, which left traces resembling craters the familiar from the aerial bombs. Moreover the craters, formed during many millions of years on the moon remained invariable due to the absence of water, and air, which cause erosion on the earth. The other theory compares lunar cratets to terrestrial volcanos, or better, to the past volcanic activity, which according to the latest observa-- tions is up to now not quite dead.

In favour of the metorite theory is the fact, that even on the earth was found a lot of traces from the falling of large meteorites like the famous Tunguss meteorite, which was, perhaps the remains of a comet, and besides the well known meteorite craters in Arizona and Estonian island Sarema, apparently, of comparatively recent origin and therefore well preserved, quite a lot has been discovered of remains of meteorite craters already destroyed by erosion. However, the statistics of crater distribution on the moon has shown considerable inequality and even some excess of craters on the other side of the moon, which is behind it in its movement around the earth, i.e. where the meteorites should be overtaking the moon, and therefore, it seems, should have been falling less frequently.

In the new pictures of the other side of the moon, obtained by the interplanetary station "Zond-3", can be seen with amazing clearness at many points chains of craters along the extensive cracks, which, apparently, could originate only as a result of volcanic activity. Of course, there are also craters on the moon of meteorite origin, but these are mainly of comparatively small size and time only the subordinate roleas compared to larger formations of volcanic origin.

The new Soviet picture of the other side of the moon brings us very much closer to puzzling out the questions on the structure of its surface and about the origin of various formations on it.

"Pravda", 24th August 1965.

TASS COMMUNIQUE ON THE LAUNCHING OF AUTOMATIC STATION "VENUS-2"

In accordance with the program for research of space and planets of the solar system the Soviet Union has launched on the 12th November 1965 a space rocket with automatic interplanetary station toward the planet Venus.

The last stage of the rocket was preliminarily inserted into interim orbit of artificial earth satellite, then took off from this or it and placed "Venus-2", on the path to Venus. The station weighs 963 kg.

The flight of the station to planet venus on the selected path will last for three and a half months.

The station "Venus-2" carries scientific instruments, by means of which it is proposed to condouct expensive space research during its flight to the planet.

Chemical and solar batteries are used for the power supply of the airborne equipment of the station "Venus-2".

The telemetric, measuring and scientific instruments are switched automatically in accordance with the flight program, as well as on commands from the earth. A special measuring complex on the territory of the Soviet Union is conducting the tracking, determination of trajectory parameters and reception on earth of the scientific information.

The automatic station "Venus-2" is moving along a trajectory close to calculated one.

At 12 hrs Moscow time on the 12th November 1965 the station was 56 thousand km from the earth above a point of the earth surface with coordinates 104°19' E and 26°37' N.

The coordination center is conducting processing of all the incoming information.

" Pravda", 13th November 1965.

TASS COMMUNIQUE ON THE LAUNCHING OF AUTOMATIC STATION "VENUS-3"

On the 16th November 1965 an automatic interplanetary station "Venus-3" was shot toward the planet Venus.

The pattern of "Venus-3" insertion into heliocentric orbit is similar to that of the "Venus-2".

The main object of launching "Venus-3" - enlarging the volume of scientific information and obtaining of additional scientific data on planet Venus and the outer space.

The automatic station "Venus-3" weighs 960 kg.

Its construction is slightly different from that of "Venus-2" by the composition of scientific equipment. This station is meant to resolve a number of new research problems.

The automatic interplanetary station "Venus-3" was placed in trajectory close to calculated one. The ground command center is tracking both the stations and controls operation of their systems.

According to data of telemetric information, all the systems of "Venus-3" operate normally. At 12 hrs Moscow time on the 16th of November 1965 the automatic station "Venus-3" was at 65 thousnad km from the earth above a point of terrestrial surface with coordinates 23°25' N and 99°39' E.

The coordiantion center is processing all the incoming information.

"Pravda", 17th November 1965

TASS COMMUNIQUE. A MESSAGE BAG WITH USS EMBLEM OF PLANET VENUS

On the 1st of March 1966 at 9 hrs 56 min Moscow time the automatic station "Venus-3" after three and a half months flight in space reached planet Venus and delivered on its surface a message bag with the Emblem of the Union of Soviet Socialist Republics.

The exact randevous of the automatic station with the planet was assured by the successful correction of the path of flight of the station on the 26th December 1965. Throughout the flight regular radio-communication was maintained with the station and reception carried out of scientific information. On the terminal stage of the station's approach to planet Venus no communiction session has been held.

The other automatic station "Venus-2", launched on the 12th of November 1965, continuing its flight along the heliocentric orbit passed on the 27th of February 1965 at 5 hrs 52 min Moscow time at a distance of 24 thousand km from the surface of Venus.

The flight of the station at prescribed distance from the planet without correction was assured only by the exact insertion into interplanetary trajectory.

The experiments, conducted by means of automatic stations "Venus-2" and "Venus-3", made it possible to resolve a number of principally new problems of interplanetary flight and to obtain new scientific data. The material of the flight of these stations are being processed and studied.

"Pravda" 2nd March 1966

ABOUT THE FLIGHT OF AUTOMATIC INTERPLANETARY STATIONS "VENUS -2" AND "VENUS -3"

Since long the attention of the sceintists and of the whole mankind is being drawn to the planets nearest to earth. Observation of the planets from earth has enabled to obtain important information about their nature, however, due to their distance, and also the presence of the earth atmosphere, interfering with observations, many most important characteristics of the planets cannot be investigated from the earth.

Specially mysterious in the celestial bodies is the planet Venus- nearest to us after the moon. The best ground telescopes are able to distinguish on Venus details not less than 500-1000 km however the many-years observations failed to discover the presence of any visible details, since the surface of the planet is constantly covered by a compact opaque layer of clouds. Until recently it was impossible even to determine the vevolution speed of the planet about the axis. Only the radar observations, conducted in USSR and USA in 1960-1962 enabled to estimate the rotational speed of the Venus. It was found to be quite low in comparison with the rotational speed of the earth: the planet completes one rotation about its axis in almost 200-300 terrestrial days.

Measurements of the planet's surface temperature, conducted from the earth by investigating its infrared and "radio-interference" radiation, produced results, which so far cannot be explained theoretically: the infrared radiation corresponds to very low temperature, about 40°C, whereas the radio-interference radiation in cm and mm wave band corresponds to the beating of surface up to 300-400°C. These results are being explained at present by menas of various hypotheses. One of the most probable hypotheses is the assumption, that the surface of the planet is really heated up to 300-400°C due to intense "greenhouse effect". It is built up by the clouds of the planet capable of transmitting to the Venus surface solar heat, but almost fully inhibiting return radiation. However, for the heating up to this temperature requires an extremely high imperviousness of the clouds for infrared rays. This effect cannot as yet be fully explained theoretically.

Due to the fact, that the hypothesis of the "greenhouse effect" is not fully proved, there are other assumptions, for instance, about their generation due to the intensive motion of electrons in atmosphere or inosphere.

Investigation of the actual physical conditions on Venus, sharply different from terrestrial object, is of exceptional sceintific interest. These stirring questions could be resolved only by means of automatic interplanetary stations, directed into immediate vicinity of the planet, orbiting it at short distance or descending directly into the path of its atmosphere.

In construction of these stations a whole series have to be resolved of principally new problems, such, as the placing of the station into interplanetary orbits, fixing of radio-communication at distance of tens and hundreds of millions of km, construction of new equipment for controlling the station and conducting measurements, as well as development of instruments for the scientific research.

By launching the automatic stations "Venus-2" and "Venus-3" the Soviet Union has undertaken the first serious attempt to investigate directly this planet.

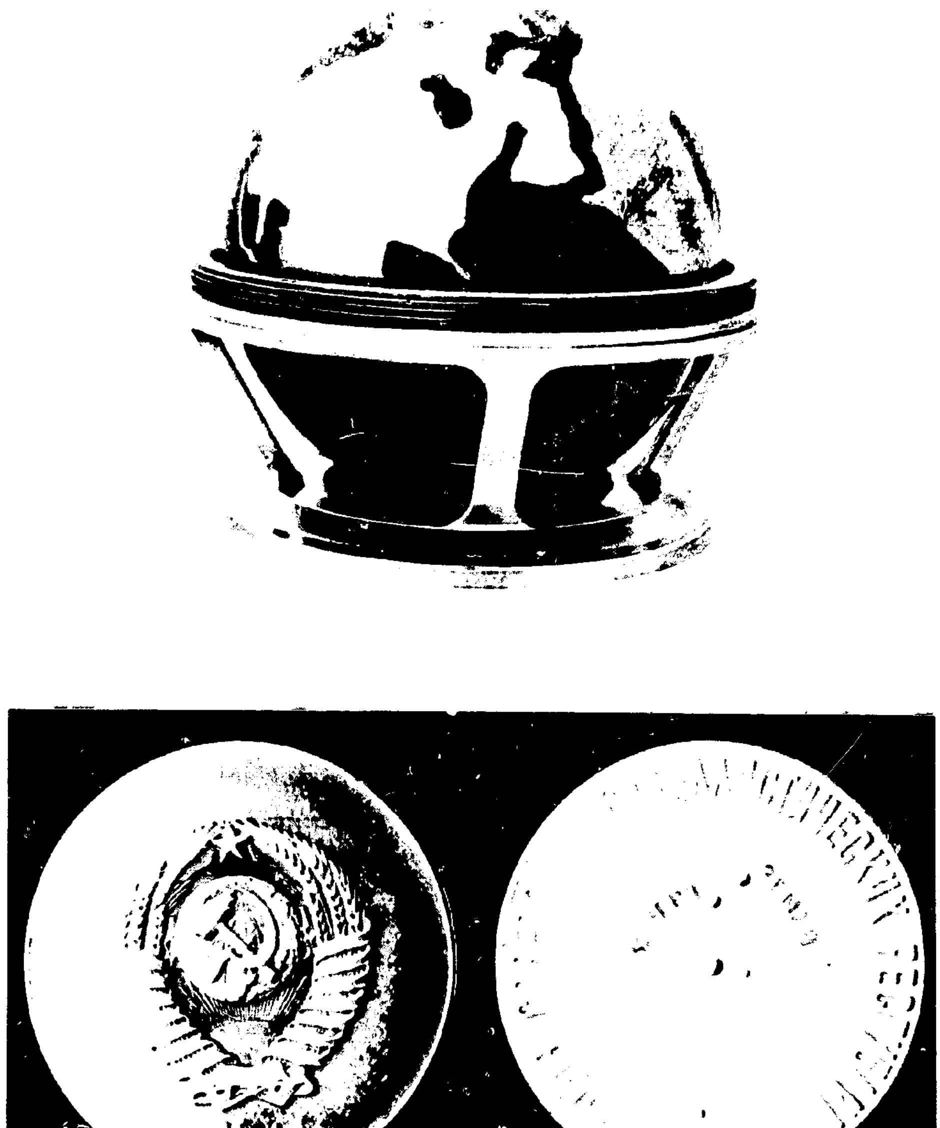

Figure 13 Message bag and medal, delivered by the Soviet automatic station to Venus.

Arrangment of the Automatic Interplanetary Stations "Venus-2" and "Venus-3"

The scientific object of the stations flights envisaged on the first stage- interplanetary space research on the flight path between the orbits of earth and Venus, at the second stage - nature investigation of the planet venus.

In order to provide for an extensive study of the planet it was proposed to conduct investigation by two methods: "Venus-2" should have passed at close distance from the surface of the planet, conduct a number of physical measurements and to photograph the planet. "Venus-3" should have entered into dense atmospheric layers of the planet and to transmit the results of direct measuring of temperature and pressure on the surface.

The construction of "Venus-2" and "Venus-3" has a lot in common with construction of stations "Mars-1", "Zond-2" and "Zond-3".

The stations are composed of two pressurized compartments-orbital (Fig.14) The special compartment of "Venus-2" contains photo-television equipment, radio-transmitters of cm band, one of the storage batteries and a part of the electronic equipment for the functioning of compartment and some scientific measurements.

The special compartment of "Venus-3" is the descent vehicle made in the shape of a sphere 900 mm in diameter. The surface of the sphere is covered with heat-resistant coating, for protection against high temperatures during braking in dense atmospheric layers of Venus. The descent vehicle contains transmitters of decimeter waveband, which would have transmitted to earth the main parameters of the planet's atmosphere and surface, measured by scientific instruments. The landing on the surface is by means of a parachute system.

The descending vehicle carries also a message box with the emblem of the Soviet Union. The message box is a hollow sphere 70 mm in diameter, engraved on the surface of which are the outlines of the earth's continents. Inside the sphere is a medal on one side of which is the emblem of the Soviet Union, and the other - the solar system planets and the words "Union of Soviet Socialist Republics. 1965". The position of earth and Venus on the medal corresponds to the time of the stations approach to Venus.

Prior to take off the descending vehicle of the station "Venus-3" was thoroughly sterilized. [illegible] to destroy all the micro-organisms of [illegible] origin [illegible] to prevent the [illegible] of [illegible] Venus.

[illegible] radiators [illegible] systems, [illegible] batteries, [illegible] -[illegible] orientation [illegible].

The main equipment for the station's function in trajectory is concentrated in the orbital compartment. It contains storage batteries, transmitters and receivers of decimetre band, telemetric commutators, instrumants of the orientation system and movement correction of the station, electronic-optical sensors of the station's attitude and gyroscopic devices.

The orbital compartment contains also electronic programing device for the control of all the station's systems and automatic switch of equipment for radio-communication at prescribed time inervals, Moreover the communication can be started on command from earth.

Normal performance of the station's instruments requires certain thermal conditions, provided by the thermal control system. The main source for power supply of the whole station's equipment are the solar batteries, arranged on two panels, connected to them in parallel are the buffer batteries.

The transmitters of automatic space stations, operating in decimeter and centimeter wave bands, can be connected one by one to the pencil beam antenna in the shape of a paraboloid. By means of this antenna the whole emitted power of transmitter is directed to the earth in a narrow beam, which considerably raises the reliability of radio-communication and increases the rate and quality of information transmission.

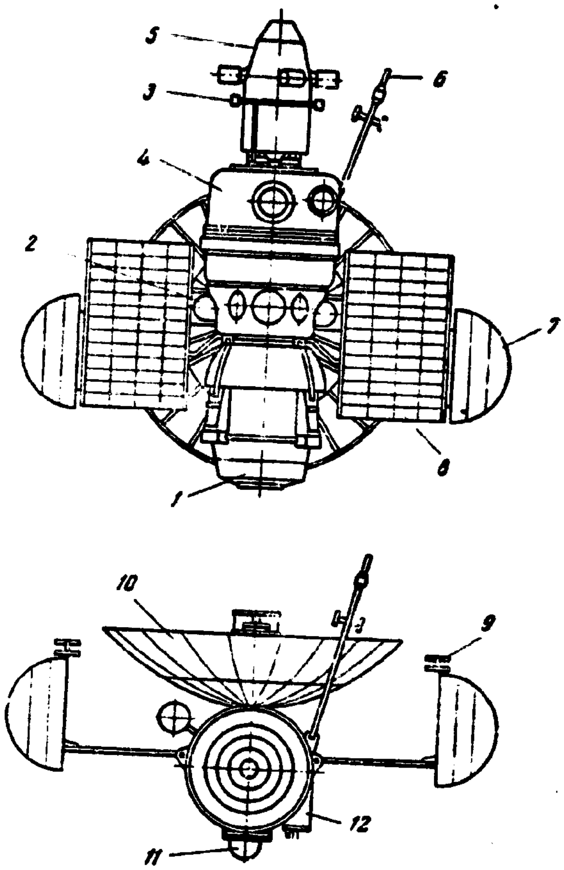

Figure 14. Diagram of station "Venus-2"("Venus-3").

1- special compartment;
2- balloons of orientation system;
3- microrockets of orientation system;
4- orbital compartment;
5- correcting propulsion system;
6- magnitometer rod;
7- radiators of thermal control system;
8- panels of solar batteries;
9- low-radiation antenna;
10- pencil beam antenna;
11- sensor of exact stellar and solar orientation;
12- constant solar orientation sensor.

The reception of radio commands aboard the station is through non-directional antenna. To the same antenna can get connected radio-transmitter of decimeter band. Thus, the radio communication can be implemented without orientation on earth, true, with somewhat lower rate of information transmission than through the parabolic antenna.

Radio-receivers of the interplanetary stations, besides the commands, receive also special radio-signals from earth for distance measuring between the station and the earth and recession speed of the station from our planet. From the time, required by the signal to pass from earth to the station and back, determination is of the distance, and from the change in the signal's frequency (Deppler effect) - the recession rate of the station. Moreover, the ground receivers measure the angular coordinates of the station, i.e. angles, at which the interplanetary station is visible from the earth. Distant-space radio center maintains a two-way communication with the station by meanns of super-sensitive receivers and powerful transmitters.

One of the most responsible systems of the station is the orientation and correction system. This system provides the required orientation of the station in space at various stages of the flight.

The orientation system of the automatic stations includes electronic-optical sensors, gas-jet microrockets, gyroscopic meters of the station's rotation speed and control devices. The attitude of the station is determined by the electronic-optical sensors, in the vision field of which should be the sun, star or the earth. With the station's deviation from the prescribed position signals arrive from the sensors into control system which by means of microrockets returns the station into initial position.

The responsible task of the control system is the maintenance of invariable orientation of the solar batteries so that they will be illumined by direct rays of the sun throughout the flight. A special electronic-optical sensor is used for the constant orientation of the stations on the sun, which enables to find the sun from any orientation of the station. When the sun falls into the vision of the central tube of the sensor, this orientation of the station's is maintained until the next maneuver.

Before beginning radio-communication by means of the parabolic antenna the station must take such an orientation, that the axis of the antenna during the session would be directed to the earth with accuracy up-to fractions of a degree. This orientation is obtained by means of a sensor consisting of two optical tubes - "solar" and "terrestrial". The axis of "terrestrial" tube is directed along the axis of a parabolic anteena , wheseas the "solar" tube can turn in accordance with the changes in the angle"sun-station-earth".

During the station's flight along the interplanetary path the orientation is done in the following order. The station turns and captures the sun by the "solar" tube. Then the station turns about the axis of the "solar"tube until the earth gets into "terrestrial" tube's vision field. After this the rotation of the station ceases, the transmitter gets cut-into the parabolic antenna and the transmission begins of the information. Throughout the whole communication period the station's orientation on both the luminaries is maintained by means of a control system. At the end of communication the station returns to permanent orientation of the solar batteries on the sun.

There is a special star-sensor for the station's orientation during correction. By menas of this sensor the longitudinal axis of correcting propulsion system, coinciding with the longitudinal axis of the station, could be oriented in any direction. This sensor is a composite electronic-optical device with mobile optical tubes - "solar" and "stellar". The angles between the longitudinal axis of the station and optical axis of the"solar" and stellar" tubes are determined by taking into consideration the trajectory measurements: the values of these angles are transmitted on board on command radio-line. After the transmission of these values the optical tubes turn into prescribed position in relation to longitudinal axis of the station. At the start of the astro-correction the station turns in space until in the vision field of the sensor's optical tubes will appear first the sun and then the star canopus. Since the sensor's tubes are already truned to prescribed angles, the axis of the station's engine takes up the required position for correction. In this case a very high accuracy of the orientation is obtained within a few angular minutes.

The correction system also includes liquid-propellant rocket engine and two gyroscopes. One of the gyroscopes is meant for "memorising" the station's orientation prior to cut-in and during the engine's operation, the other- for the cut off of the engine, when the prescribed velocity has been obtained.

The Flight of Automatic Stations to Planet Venus

The station "Venus-2" was launched on the 12th of November 1965 with the object of flight in the vicinity of the planet venus. To implement the set task it was necessary to assure, that it will fly past the venus on the side, illumined by the sun, at a distance of not more than 40 thousand km from the surface. On the 16th of November was launched station "Venus-3" with the object of reaching the planet's surface.

For convenience of radio-communication the station had to lend in the center of the disc of planet visible from earth.

The launching of each station into interplanetary path was carried out in two stages. Initially the last stage of the carrier rocket with the station was placed into the orbit earth satellite. Then at a prescribed moment the last stage was launched from the orbit of earth-satellite and the station was placed into flight path to Venus. Fig.15 shows diagram of the stations flight to venus and position of the planet at different moments of time.

Implementation of the taks, assigned to the stations, requires very high precision in the insertion of interplanetary vehicles on the movment trajectory to venus. During the insertion into interplanetary route the velocity of both the stations at the moment of the last stage engine cut-off composed about 11500 m per second. At these velocities deviation of terminal velocity by 1 m per second results in deviation at the planet of about 30 thousand km. To provide such accuracy in insertion is extremely difficult technically, therefore for both the interplanetary stations the possibility was provided for the movement correction during the flight.

The movement correction could have been done several times and by different methods. The correction could be "solar-stellar" or "solar". In the first case operates the "solar-stellar" orientation system, which uses as check luminaries the sun and the canopus star. This system makes it possible in principle to orient the axis of correction motor in any direction in space, which provides the possibility not only to ensure the station's landing at prescribed impact point, but also changes the time of its rendevouz with the planet. This last is necessary to ensure to approach of the station to planet venus during the period of their visibility from distant-space radio center.

In the case of the "solar" correction the axis of correcting motor is directed on the sun or away from the sun, depending on deviation of the actual path from calculated and fixed. The correcting velocity and the "sign", determining its direction are transmitted aboard the station. This method, not intending the use of the star, is technically more simple. However with some deviations of the actual path from the calculated one it introduces certain limitations and requires several corrections at definite moments. Both these methods of correction were checked in flights of "Zond-1" and "Zond-3".

Parameter measuring of "Venus-2" and"Venus-3" flight path and prediction of the motion were implemented by special radio facilities and computing center.

During the trajectory measurements distance was determined to the stations, radial velocity and angular coordinates of the stations. This enabled to determine with high precision the elements of the trajectory of stations: velocity components and coordinates.

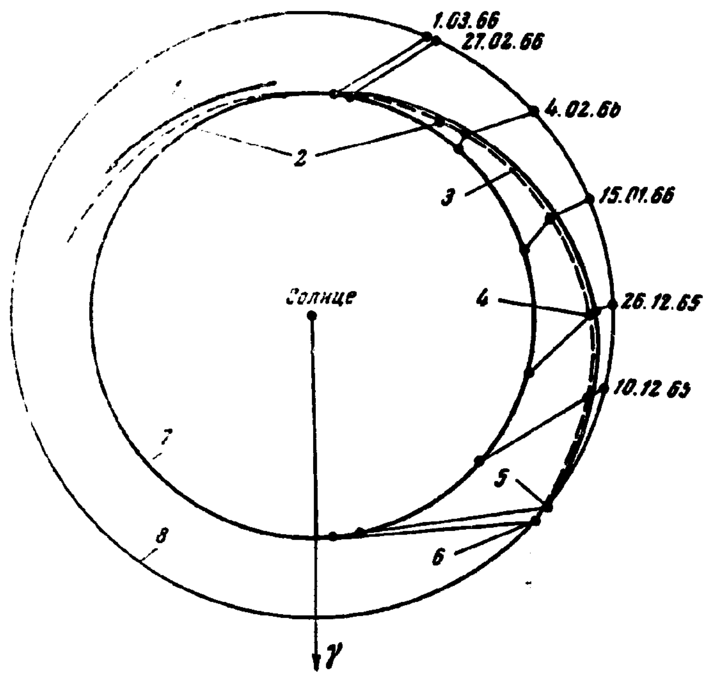

Figure 15. Flight diagram of station "Venus-2" and "Venus-3"

1- flight direction;
2- trajectory of "Venus-2";
3- trajectory of "Venus-3";
4- correction moment;
5- take off on the 16th of November 1965;
6- take off on the 12th November 1965;
7- Venus orbit;
8- Earth orbit.

The results of trajectory measurements were processed on computers independently by several computing centers. In order to obtain highly accurate prediction of stations movements a large volume of flight path measurements was implemented. In particular, for the station "Venus-3" the measurements were carried out during 31 communications, including 16 times in the branch prior to correction. The total volume of information obtained in this case, composed over 1300 distance measurements, 5000 radial velocity measurements and 7000 angular coordiantes measurements.

As a result of processing trajectory meausurements after the insertion of station into interplanetary orbit it was fixed, that the flight path of the station "Venus-2" is close to calculated one. Minimum distance of the flight at the planet is 24000 km from the surface, and the flight is above its illumined part. Thus, the flight conditions were fully corresponded to the set demands and there was no need to correct the movement trajectory of "Venus-2". Figure 16 shows the flight diagram of the station in the vicinity of planet venus.

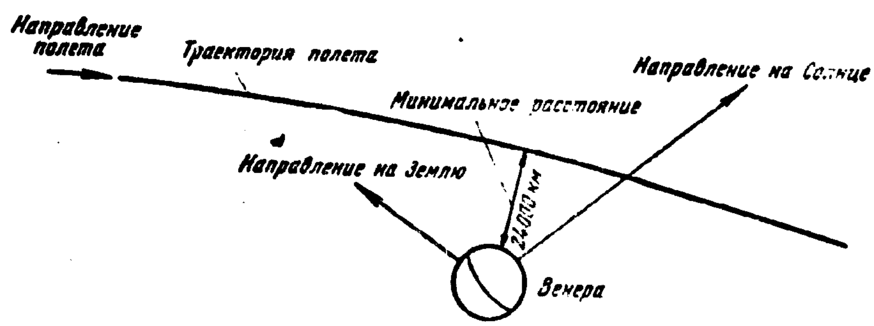

Figure 16. Flight diagram of the station "Venus-2" close to planet Venus
1- Flight distance 2- Flight path 3- Minimum distance
4- Direction to sun 5- Direction to earth 6- Venus.

The station "Venus-3", according to measurements data, after insertion into interplanetary path should have passed at 60,550 km from the center of the planet at 0 hrs 0 min 37 sec on the 1st of March 1966. At this time the station could not be observed from distant-space radio center. Therefore it was necessary to carry out correction, which has been done on the 26th of December 1965 at 18 hrs 04 minutes when the station was 12,900,000 km from the earth. The correction was carried out with the use of "solar-stellar" orientation.

The required correction impulse with two angular settings was transmitted on board the station. As a result of correction raidal velocity of the station should have changed by 19.75 m per second. According to plan after corfection the station should have reached the venus surface at 10 hrs in the morning Moscow time on the 1st of March 1966 in the center of the disc of the planet visible from earth. Immediately after correction the actual change or radial velocity was measured. It composed 19.68 m per second, differing from the prescribed velocity only by 0.07 m per sec. Such low deviations in correction velocity were provided by high accuracy of orientation and impulse operation by correcting motor. Processing of trajectory measurements, conducted during the flight from the moment of correction to 15th February 1966 inclusive, has shown, that the actual trajectory of "Venus-3" differs very little from the prescribed one and deviation of the actual landing point from the calculated one is not above 450 km. The rendevouz time of "Venus-3" with the planet was falling at 9 hrs 56 min 26 sec Moscow time on the 1st of March 1966, which differed from the preset by less than 4 min. The angle between to earth and local vertical at landing point composed $1^{o}30'$. Thus, there was no need for additional correction of the flight path.

During the processing of the actual orbit of the station serious attention was paid to estimation of the maximum errors in coordinates determination of the station's landing point on the planet venus.

It is well known, that prediction accuracy of the station's movement is determined by two groups of errors:

- negligible incidental and systematic errors in radio-technical measurements of distance, radial velocity and angles;
- errors in knowing the astronomical units(mean distance of earth from the sun) and other astronomical constants.

Detailed processing of trajectory measurement results has shown, that due to instrumental errors of measurement maximum deviation of the actual;anding point of "Venus-3" from the predicted is not over 600 km. Whereas the maximum error in predicting coordinates of the station's landing point due to errors in astronomical constants does not exceed 500 km.

Thus, the total maximum error in calculating coordinates of the station's landing point on planet venus, obtainable as mean square of these values, is not over 800 km. It means, that the actual movement trajectory of the station due to pointed out errors may differ from trajectory, determined from results of measurements (in Fig.17 it is denoted as "actual"), by plus minus 800 km. Therefore, the actual trajectory will be in the narrow tube, denoted in Fig.17 as "limits of possible trajectory deviations". Error in the rendavouz time of the station with the planet compses, according to the calculation results, only ± 5 minutes.

Further measurements during the approach of the station to planet have shown acceleration in the movement of the station, caused by the direct attraction of the planet.

It should be mentioned, that venus, having considerable mass, equivalent approximately to earth mass, exerts high attraction on approaching space bodies. Thus, for instance, the capture region of the interplanetary station"Venus" (region of stricking the planet trajectories, see Fig.17) is determined by a circle with radius of 15,000 km, considerably exceeding the geometrical radius of planet venus(6100 km). Therefore, the impact with the planet was mesured even in the case, if the errors in predicting coordinates of landing point were greater than the indicated 10-15 times.

As a result of "Venus-2" and "Venus-3" flight a lot of various data of trajectory measurements were obtained of. These are of independent scientific significance for studying the problems of super-distant measurements and interplanetary flights. The difficulty of planning interplanetary space stations is that we are not sufficiently familiar with the physical conditions of the station's flight in the interplanetary space. Moreover, during the tests on the earth of these vehicles it is difficult to create conditions, completely identical to conditions in space. Final tests of the airborne systems and stations take place mainly during the actual flights, with launching for the purpose.

The flight of automatic stations "Venus-2" and"Venus-3" has shown, that the operating conditions of space vehicles in direct vicinity to venus are still known. During the approach of the stations to planet considerable rise was noted, same as on the American vehicle "Mariner-2", of temperature, exceeding calculated values. Some disturbances were also noted in radio-communication on the approach to the planet. The last session of radio-communication with the station "Venus-3" could not be held on its approach to the planet. The disruption cause of radio-communication has not as yet been fixed. At present a detailed analysis is being conducted of the station's performance from results of telemetric information at the previous sessions.

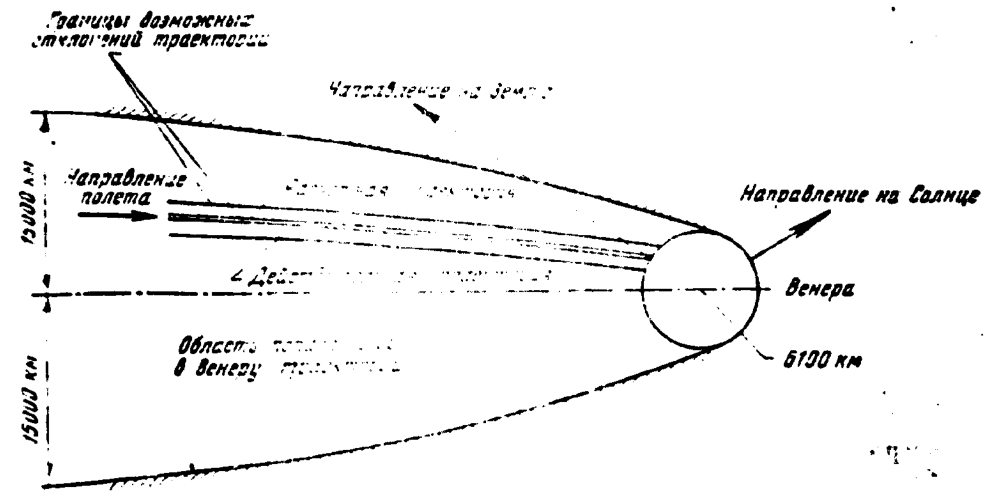

Figure 17. Diagram of the approach of "Venus-3" with the planet venus.

1- limits of possible trajectory deviations.
2- Direction of earth
3- Flight direction;
4- Calculated trajectory;
5- Actual trajectory;
6- Region of trajectories stricking into venus;
7- Direction to the sun.

On the approach of the station "Venus-2" to plamet the necessary commands were issued on board, including independent investigations during the approach session according to the predetermined program. No confirmation was obtained on the passage of these commands. The result of experiment will become known, if radio-communication is restored with"Venus-2"

At present the station "Venus-2" is continuing its flight in heliocentric orbit. On the 4th of March its recession from the earth was about 6[illegible] million km.

Altogether during the flight 63 communication sessions were held with "Venus-3", with "Venus-2" - 26 sessions. The greater number of communications with "Venus-3" was connected with the object of more exact measurement of the trajectory. Throughout the flight in trajectory scientific data and telemetric information on performance of the station's systems were being transmitted to earth during the communication sessions.

Physical Research in Flight.

Interplanetary space is an object of numerous scientific investigations. Out of the sun to every side flows more or less [illegible] with a velocity of about [illegible] km per second [illegible], the so-called solar wind. The active regions of the sun occasionally "eject" a flux of particles with velocity 1000-[illegible] km per second, and sometimes even very high-energy particles or solar cosmic rays. [illegible], incoming from beyond solar system are particles of enormous energies, moving at speed, very similar to that of light, - cosmic rays. The concentration of charged particles is paraticularly high in the vicinity of the earth - in its radiation belt, where these particles are held by the terrestrial magnetic field.

The flux of solar particles carry a magnetic field, although weak, but quite measurable by the instruments of space rockets, receding beyond the limits of terrestrial magnetosphere.

It is of considerable interest to study these effects at present during the period of minimum solar activity, when the occasional, isolated ejection of matter from the sun and the magnetic disturbances bound with it could be followed more clearly due to them being relatively rare. Very essential, in particular, is the investigation of transitory region from magnetic field of the earth to interplanetary magnetic field, i.e. boundary determination of terrestrial magnetosphere.

The exit of the station beyond the limits of matnetosphere permits to study the low-energy component of cosmic rays, which does not reach the earth's surface due to its magenetic field. It is precisely this component that mainly determines the change in cosmic rays intensity during the eleven years cycle of the solar activity, and the sudden rise of the radiation dangerous to spacemen during the solar chromospheric flares. The study of the variation of cosmic rays intensity with the recession from or approach to the sun is of enormous sceientific interest.

For the study of physical conditions in the outer space the station "Venus-2" and"Venus-3" carried the following sceientific instruments:

- three-component ferroprobing magnetometer for measuring interplanetary magnetic fields;

- gas-discharge counters and semiconductor detector for investigation of cosmic rays;

- special pickups (traps) for flux measruing of low-energy particles and flux determination of solar plasma and their energy spectra;

- piezoelectric pickups for investigation of micrometeors;

- radio-receiver for measuring comic radio-emission in wavelength bands 150 and 1500 m and 15 km.

This set of instruments covers the main chavacteristics of physical conditions in the interplanetary space.

Data of physical investigations obtained in the flight of stations "Venus-2" and"Venus-3" are at present under study. The results will be published in scientific journals.

(TASS)

" Pravda" 6th March 1966

TASS COMMUNIQUE " VENUS -4" IN FLIGHT

In accordance with the program for research of space and solar system planets the Soviet Union has launched on the 12th of June 1967 at 5 hrs 40 min Moscow time a space rocket with automatic interplanetary station toward the planet venus.

The last stage of the rocket was preliminarily placed into interim orbit of artificial earth satellite, then took off from this orbit and set into flight automatic station "Venus-4" weighing 1106 kg.

The flight of automatic station to planet Venus will last four months.

It is envisaged to conduct an extensive space research during the flight with the help of scientific instruments, carried by the automatic station "Venus-4".

Chemical and solar power sources are used for energizing airborne equipment of the automatic station "Venus-4".

The telemetric,measuring and scientific equipment is switched automatically in accordance with the flight program and on radio-commands from earth.

A special measuring complex on the territory of the Soviet Union is conducting tracking of the automatic station measurements of its trajectory parameters and reception on earth of the sceientific information.

The movement of the station "Venus-4" is along the trajectory close to prescribed one. At 14 hrs Moscow time on the 12th of June 1967 the station was at 112 thousand km from earth above a point of terrestrial surface with coordinates $70^{\circ}18'$ E and $6^{\circ}29'$ S.

The whole equipment aboard the automatic station "Venus-4" operates normally.

The coordination center is conducting processing of all the incoming information.

"Pravda", 13 the June 1967.

TASS COMMUNIQUE ON THE FLIGHT TERMINATION OF "VENUS-4"

On the 18th of October 1967 Soviet automatic station "Venus-4", reached plaret Venus, after covering a distance of about 350 million km. During the four-month flight the station enabled to obtain new multiple data on the physical properties of outer space.

On the approach to planet venus the station fixed non-presence of any noticeable magnetic field and raidation belt of the planet. A weak hydrogen corona was detected.

Today, 18th of October 1967, at 7 hrs 34 min Moscos time the automatic station "Venus-4" entered at escape velocity into the atmosphere of venus and the descent vehicle - scientific laboratory separated from the station. After aerodynamic braking of decending vehicle in the planet's atmosphere, a special parachute system began operating and the vehicle continued its smooth descent in the atmosphere of venus.

The sceientific instruments of descending vehicle continues steady measurements and transmission to earth of the venus atmpsphere parameters during one and half hours at the extent of 25 km. The vehicle descended on the surface of the planet, delivering a second message bag with the emblem of the Union of Soviet Socialist Republics.

Measurements were made of pressure, density, temperature and chemical composition of the venus atmospheres.

Throughout the extent of the measurements section the temperature of the atmosphere varied from 40 to 280°C, atmospheric pressure - from 1 to about 15 atmospheres. The guaging has shown, that the venus atmosphere consists almost totally of carbon dioxide; oxygen and water vapors composes about one and a half per cent, no traces were detected of nitrogen.

Data of the sceientific gauging are being processed and will be published.

Thus, the Soviet automatic station "Venus-4" for the first time accomplished a smooth descent and landing on the surface of the planet and made it possible to obtain most valuable data about the planet venus.

The scientific research, carried out by the Soviet automatic interplanetary station "Venus-4" is a new Soviet technological breakthrough, an important step in the research of solar system planets.

"Pravda", 18th October 1967

SOVIET INTERPLANETARY STATION "VENUS-4"

On the eve of the glorious anniversary of the Great October Socialist Revolution and the tenth anniversary of space research era were marked by a new brilliant victory of the Soviet science and technique. The automatic interplanetary station "Venus-4" carried out and extensive research on flight route, in circumplanetary space and in the planet's atmosphere.

In size, distance from the sun and extent of the atmosphere venus resembles earth more than any other planet. It revolves around the sun at a distance of 108 million km and completes during 225 terrestrial days complete revolution in orbit, very similar circumferance.

During the movement of the earth and venus around the sun distance between them varies from 40 to 260 million km. By means of optical telescopes it is possible to observe at this distance details of a few hundred km. However for the observation of venus these tested methods are ineffective due to its dense could cover. Therefore until now the science did not posses any authentic information ahout the physical conditions on this planet, including its atmosphere.

Indirect data on chemical composition, pressure and temperature of the venus atmosphere, based on results of ground observations, are so controversial, that they have produced a lot of hypotheses. Thus, for instance, estimates of surface temperature varied from minus 40 to plus 400°C, and the atmospheric pressure on the surface - from one to 50-100 atmosphere. Only lately by means of radar observations it was possible to estimate the rotation speed of the planet about its axis. Beginning from 1961 the Soviet and American automatic interplanetary stations have been flying to venus, and in 1966 Soviet station "Venus-3" reached the planet and delivered a message bag of the Soviet Union on its surface.

On the 18th of October 1967 Soviet automatic station "Venus-4" has successfully implemented entry into venus atmosphere, for the first time gauged the physico-technical characteristics of the atmosphere. Direct gauging of the venus atmosphere are the greatest modern technologicaal breakthrough, marking a new stage inthe study of the solar system planets.

1. AUTOMATIC INTERPLANETARY STATION "VENUS-4"

The main scientific task of the automatic interplanetary station "Venus-4" was determination of the main physico-chemical characteristics of the venus atmosphere. Moreover an extensive space research was conducted on the flight route.

The station weighs 1106 kg and consists of the orbital compartment and decending vehicle (Fig.18).

Orbital Compartment

Orbital compartment is a pressurized body of cylindrical shape with elliptical end panels. Arranged inside are the electronic devices of the radio-set, astro-orientation systems and scientific instruments. Here also are the automatic units of thermal control system, chemical current sources, capable of being charged from solar batteries, and control system.

Attached to the body of the orbital compartment are the descending vehicle, correcting propulsion system, optical sensors and operating organs of the astro-orientation system, unfolding panels of the solar batteries, and pickups of scientific instruments.

The station has a liquid-propellant rocket engine for correcting flight trajectory, so as to enable it to get into the planet. The propulsion system is provided for two corrections. During the flight of the station "Venus-4" the accuracy of the first correction was sufficient, so that the second was not required.

Descending Vehicle

The descending vehicle, meant for scientific research in venus atmosphere, has a shape resembling a sphere of 1000 mm in diameter. Its weight - 383 kg.

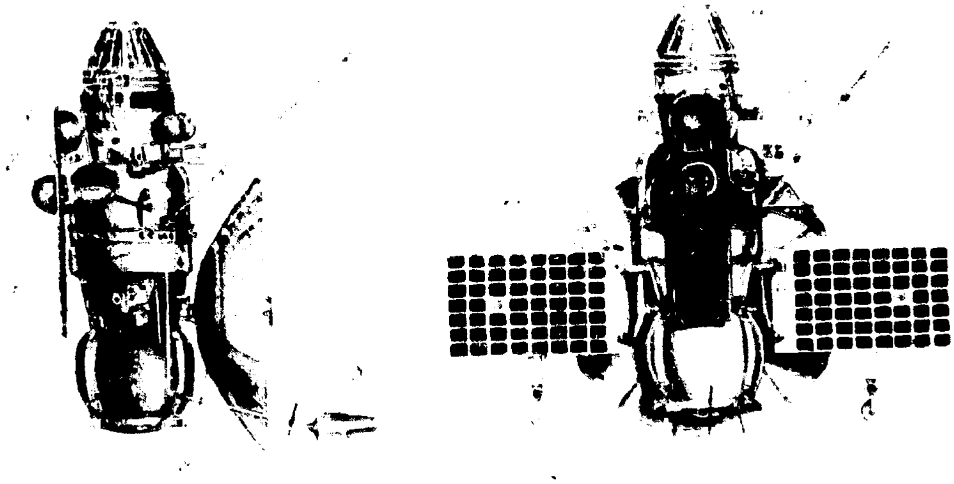

Figure 18. General view of the station "Venus-4"

1- orbital compartment(OO);
2- astro-orientation sensor;
3- sensor of permanent solar orientation;
4- gas cylinders;
5- orientation sensor"Sun-Earth";
6- pickup and rod of magnetometer;
7- pencil beam parabolic antenna;
8- non-directional antenna;
9- radiator of thermal control system;
10- Solar batteries panel;
11- correcting propulsion system;
12- microrocket of astro-orientation system;
13- counter of cosmic particles;
14- vehicle.

It is well known, what difficulties had to be overcome for descent of vehicles, moving at orbital velocity in the earth's atmosphere, the characteristics of which are well known. It can be imagined, how much difficult was the problem of constructing descending vehicle of "Venus-4", which had to enter into atmosphere of venus unknown to us not at orbital, but at escape velocity.

Entry into atmosphere at escape velocity, and successful braking of space vehicle were accomplished for the first time in the world's technique. At this velocity temperature following the shock wave, generated in front of descending vehicle, is up to 10-11 thousand degrees.

To reduce the influx of external heat inside the vehicle during the entry and aerodynamic braking, and also for protection from the "hot" atmosphere of venus the surface of the body is coated with a special heat insulation. A damper is fixed at the bottom of the vehicle, to reduce its oscillations with movement in the planet's atmosphere.

The descending vehicle has two pressurized compartments - instrument and parachute. The instrument compartment carries transmitter, telemetric system, storage battery, programing timer, units of automatics, thermal contool system, scientific instruments and radio-altimeter.

In the parachute compartment is a system of two parachutes - braking and the main one, made of heat-resistant cloth, estimated for temperature of up to 450°C. Moreover, it contains also the pickups of the scientific instruments, transmitting antenna and antennas of radio-altimeter.

The parachutes open by means of automatic system, which includes sensors of atmospheric pressure and overstrain, and the programing timer. When the speed of descending vehicle is reduced after the aerodynamic braking from 10,700 m per second, the braking and the main parachutes are activated on command of external pressure sensor and reduce the descent velocity to a few meters per second.

Simultaneously with the main parachute open out the antenna system and the radio-altimeter and transmitter, which spends scientific information to earth, are switched in.

Prior to take off the descending vehicle of "Venus-4" was sterilized.

The descending vehicle carries two message bags with the emblem of the Union of Soviet Socialists Republics, which were delivered on the surface of planet venus.

Radio Equipment of the Interplanetary Station

The radio equipment of the station provides for trajectory parameters measurement, memorizing and transmitting of service and scientific information and also control of the systems performance on commands from earth.

The orbital compartment, besides the two receivers and transmitter, contains telemetric commutators, decoders, memory and auxiliary electronic equipment. Part of the radio equipment in descending vehicle includes two transmitters, telemetric commutator and programing mechanism. Moreover, there is an autoamtic device for the switching over of transmitters in the case of failure of one of them.

The station's communication with earth was in the decimeter band of radio waves. Three airborne antennas were used during the flight; one pencil beam with parabolic reflector about 2.3 m in diameter and two non-directional. Depending on the session's program the selection was of one of these antennas by feeding corresponding commands from the airborne block of automatics or from the earth. Information transmission from descending vehicle during its lowering on the parachute was through a special antenna, which concentrated energy in comparatively narrow,cone, within which was the earth. During the flight transmitters of descending vehicle could be cut in to any of the non-directional antennas of the orbital compartment.

In between the communication sessions the airborne radio equipment was on duty, when decoders of command radio-line and one of receivers, connnected to non-directional antenna, remained cut-in. Moreover, in these conditions the reading of the scientific instruments was fed through telemetric commutator into a special memory device. During any communication sessions this information could have been transmitted from the memory to earth.

During the communication sessions the radio equipment operated in different conditions. For telemetric transmission the corresponding commutator or memory was cut-in to transmitter on command from the airborne programing timer or on command from the earth. The rate of the information transmission was fixed in this case in relation to antenna applied and the distance of the station.

In planning and production of the electronic radio equipment special attention was paid to its reliable functioning. The launching of the station was preceded by prolonged tests of similar equipment in more difficult conditions, than those expected during the flight. Individual, the more important devices were duplicated. However there was no need to use the doubling devices during the flight, as all the equipment operated faultlessly.

Technical difficulty in receiving weak radio-signals of space vehicles, meant for research of solar system planets, is obvious. In this case the additional difficulty was due to the fact, that the most valuable information was transmitted during the approach of the stati n to venus with rapid increment of velocity. The speed of transmitter in relation to receiver changes the wevelength of received signals. Therefore in reception of signals from the station approaching venus it was necessary exactly and at high speed to reconstruct the receivers of distant-space radio center.

Power Supply System

The power-supply systems of the "Venus-4" station consists of solar batteries, arranged on two panels, chemical storage batteries and control block. The system provides for a wide range of load at minimum weight and is constructed on a circuit "generator-buffer battery". The power generator is a solar battery on emiconductor transfermers, and the buffer battery are the chemical accumulators. The buffer battery provides for energizing of the station's equipment dur ng the communication sessions. It is recharged throughout the flight from solar batteries.

There is a storage battery in descending vehicle, which during the flight is in non-operating condition and is only charged by a weak current from individual section of solar batteries. During the movement in the venus atmosphere it provides power supply to all the equipment of descending vehicle. The capacity of the storage battery was estimated for operation of equipment in descending vehicle for at least 100 minutes after separation from the orbital compartment so as to obtain and transmit information about the venus atmosphere.

Orientation of Interplanetary Station

In flight, according to program, the station is oriented in space in a quote definite way, by means of orientation and stablization system. This system carries out the following function:

- providing best working conditions for solar batteries and thermal control system;

- orientation of the parabolic antenna on earth during radio-communications;

- exact orientation and stabilization of the station in space during the trajectorycorrections.

The orientation and stabilization system includes the electronic-optical sensors, gyroscopes and control equipment. The station is turned into prescribed direction by means of gas get microrockets. The attitude of the station is fixed in relation to astronomical reference points: earth, sun and canopus star. The orientation at all the stages of the flight is executed in the following way: deviation from the prescribed referen-. is determined by the optical sensors, which give signals to control system for the switching of mkcrocorkets and the station truns until its orientation in space is according to the required one.

The basic condition of the station's flight to venus is the constant orientation of the solar batteries panesl perpendicularly to surveys. Special electronic-optical sensor enables to find the direction on the sun and to retain this orientation of the station. In this case the communication with the station is maintained through non-directional antennas. The same orientation could be executed by the turning of the vehicle about the axis, perpendicular to the plane of solar batteries. This axis is primarily oriented on the sun.

The use in radio-communications with earth of pencil beam parabolic antenna requires orientation of the station in space with high precision. This is obtained due to the fact, that the orientation of the station in this case is fixed relatively to direction on the sun and the earth. After the sun and the earth are captured in the vision field of the sensors the anteena becomes directed exactly on the earth.

The highest requirements of the orientation precision are demanded of the station during the trajectory corrections. At this stage of the flight the vehicle is oriented on the sun and canopus star. During the turn of the station both the luminaries fall into the vision field of the sensor's optical tunes and the engine's axis takes up the required attitudes.

Thermal Control System

One of the most important systems in the automatic interplanetary stations is the thermal control system. It has the responsible task of maintaining in all the compartments the prescribed temperature conditions. The required thermal conditions of the elements of construction and airborne systems is provided by the combination of passive and active methods of thermal control.

The passive method of thermal control maintains the thermal conditions for operation of correcting engine, solar batteries, antennas and equipment outside the station. This is obtained by the choice of heat insulation, optical factors of coating and other means.

Thermal conditions of the orbital compartment and descending vehicle are maintained by the active thermal control system. The action principle of this system is that in all the compartments is build up a forced gas circulation. Stream-lining the heat-emanating elements of devices and systems, the gas becomes heated and yields the excessive heat to heat-exchanger, which emmits it into the space. By controlling flow of gas, incoming into heat-exchanger, the required temperatture conditions are obtained in compartments. The thermal control system has fully implemented the tasks, imposed on it.

II The Flight to Venus

The "Venus-4" station was launched on the 12th of June 1967. Initially the vehicle with the last stage of carrier-rocekt was placed into the interim orbit of the artificial earth satellite. After orbitting the last stage of the carrier-rocket imparted to the station [illegible] velocity and [illegible] it into the flight path Venus. As a result of [illegible] radio-measurements it was fixed, that the flight path is close to [illegible] one and passes at a distance of 160 thousand km from Venus (figure 19).

For the stations impact with the planet the trajectory had to be corrected. The amount and direction of correcting momentum were calculated in the flight control center and transmitted on board the station. The correction, done on the 29th of July, 1967, when "Venus-4" station was at 12 million km from the earth, provided for reliable impact on the planet and direct radio-visibility of the station at the approach to planet from the distant-space radio center.

During over four months of flight there were 114 sessions of radio-communication, during which a large amount of information was transmitted.

Figure 20 shows [illegible] trajectory of the station and the reciprocal position of earth and Venus at [illegible] of the flight. In the flight along the heliocentrical orbit under the effect of the solar attraction as a planet of the solar system, the station covered about 350 million km. At the moment of the station's approach to Venus it was [illegible]

[illegible]

The last branch of the flight is of the greatest interest. When the vehicle was about 45 thousnad km from venus began the near-planet session; The station was orinted with parabolic antenna directed on the earth. This position the station maintained until the entry into atmosphere. Thereafter the near-planet session was terminated and descending vehicle was separated from the space station. With increasing density of the atmosphere the breaking of descending vehicle was initially sharply increased. The overstrain was more than 300 times greater than the terrestrial acceleration. When the velocity decreased to about 300 m per second, the parachute system was brought into action.

At the moment of opening of the main parachute, the transmitter of descending vehicle was started. The transmission of the data about the planet's atmosphere began. From the gauged atmospheric parameters calculations of the further movement of descending vehicle were made. After 94 minutes the station ceased to transmit information. Until this moment the pressure and temperature of the atmosphere were gradually rising.

Processing of radio measurements made it possible to fix the position of projection onto venus surface of the entry point of station into atmosphere with accuracy up to 500 km. It is on the night side of venus, in the vicinity of equator about 1500 km from the terminator(shadow boundary). This permits to conclude, that the whole descent was on the night side of the planet.

C-14

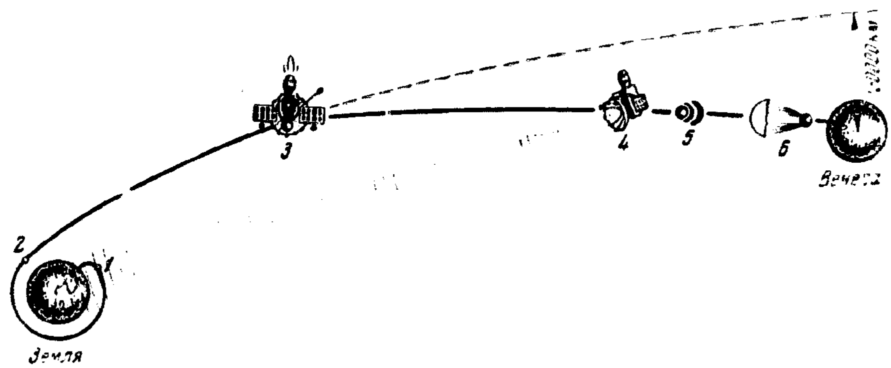

Figure 19. Diagram and the main stages of the "Venus-4" flight.

1- insertion into interim orbit of artificial earth satellite;
2- exit into flight path to venus;
3- correction;
4- near-planet session. Radio communication with earth on parabolic antenna;
5- braking of descending vehicle in the atmosphere of venus;
6- descent on parachute, scientific measurements and transmission of information to earth, landing.

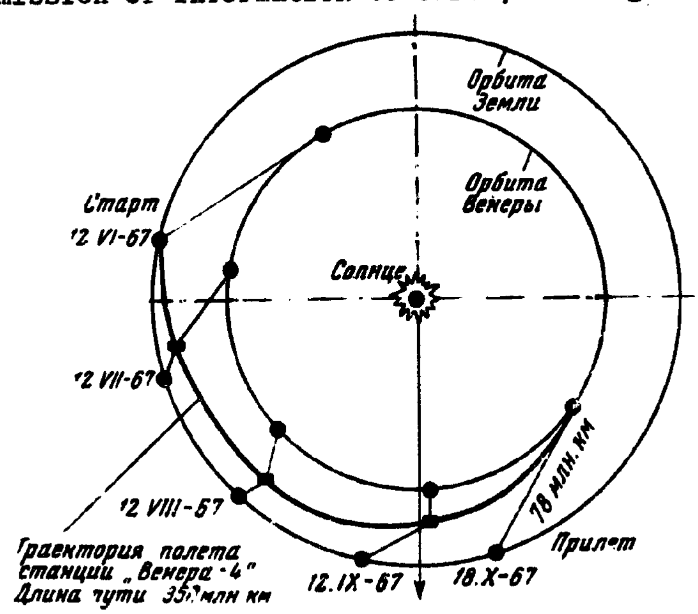

Figure 20. The flight diagram of the station and reciprocal position of earth and venus.

1- take off 2- flight path of the "Venus-4" station. Length of route 350 million km. 3- earth orbit. 4- venus orbit. 5- Sun. 6- arrival

III Scientific Research

Scientific research was conducted by "Venus-4" station throughout the flight Earth-"Venus, in circumplanetary space of venus and in dense layers of its atmosphere. The orbitel compartment carried the following scientific devices: three-component magnetometer with measuring range of 50 gammas (5.10^{-4} oersted) and 2 gamma sensitivity counters of cosmic rays particles, indicator of the ultraviolet radiation of the sun, discribed by particles hydrogen and oxygen for recording these gasés in circumplanetary space, traps of charged particles for the study of circumplanetary plasma (ionosphere).

These instruments conducted measurements throughout the flight until the moment, when the orbital compartment entered into the upper atmospheric layers of venus and ceased to function. Measurements, obtained during the flight in heliocentric orbit, confirmed scientific data of the previous interplanetary flights. At the same time measurements, conducted during the flight of "Venus-4" station, have shown, that in 1967 the flare intensity of the solar cosmic rays increased hundreds of times in comparison to 1964-65. This is bound with increased solar activity. It may be expected, that at the peak of the solar activity, which is expected in 1969, the flares intensity of the solar cosmic rays will be even higher.

Observation on the near-planet branch of trajectory has shown, that the flux of high-energy cosmic particles remained invariable up to 5 thousand km from the venus surface and was equal to flux far from the planet. With the closer approach to venus the flux decreased due to absorbtion of cosmic rays by the planet. This result shows, that there are no radiation belts on venus, similar to terrestrial.

One of the tasks of the "Venus-4" station was the investigation of the magenetic field of venus. During the flight to venus in 1964 of American station "Mariner-2" it was fixed, that the dipole magnetic field of venus is not above one tenth of the magnetic field of the earth. Preliminary analysis of the results of measurements of "Venus-4" station on trajectory up to a few hundreds of km from the venus surface permits to draw conclusion, that venus is devoid of magnetic field, dipole moment of which would have composed over three ten-thousandths of dipole magnetic field of the earth. This result has considerably verified data, obtained by "Mariner-2"; it is specially interesting due to the fact, that prior to the flights of space vehicles to celestial bodies the ideas were dominant, that all the planets of solar system have magnetic fields similar to earth.

The forthcoming detailed analysis of experimental data will make it possible to confirm further this value and, besides , to define, whether the planet has disturbing effect on magnetic field in circumsolar space.

Preliminary examination of results from experiments with traps of charged particles has shown, that the concentration of charged particles in the investigated region of the venus upper atmosphere (at altitudes over 100 km) is not above 1000 particles in cu.cm, i.e. at least by two orders less than the maximum concentration of charged particles in the earth's ionosphere. The question regarding ionosphere of venus was repeatedly discussed during the last few years and a number of authors considered, that the concentration of charged particles in the upper atmosphere of venus exceeds by several orders concentration in ionosphere of earth. Measurements, conducted on "Venus-4", have shown, that in actuality the ratio is inverse.

The equipment for recording dispersed ultraviolet radiation of sun by particles of hydrogen and oxygen in the interplanetary space and in the atmosphere of venus detected presence of the neutral hydrogen, starting from about 10,000 km from the planet's surface, Measurements have shown, that the hydrogen corona of venus contains approximately thousand times less of hydrogen than the upper atmosphere of earth. The presence of the hydrogen corona is explained by the fact, that hydrogen in the atmosphere of venus, just as in the earth's atmosphere, flows out into interplanetary apace, forming on extended shell. As regards the atomic oxygen, it was not detected throughout the extent of orbital compartment entry into atmosphere, from which it follows, that the quantity of oxygen at altitude of over 200 km is hundred million times less, than in the earth's atmosphere at corresponding altitude.

The descending vehicle carried the following equipment for investigating the dense layers of venus atmosphere: two resistance thermometers, barometric pickup, densimeter, 11 gas-analysater-cartridges.

These instruments permited for the first time to obtain directly gauged data on temperature, pressure and chemical composition of venus atmosphere.

Presence of atmosphere on venus was proved in 1761 by M.V.Lomonosov. Later by spectroscopic methods it was fixed that the atmosphere of venus contains considerable quantity of carbon dioxide, however its relative content was not known. The pressure of venus atmosphere was also unknown. Radio-astronomic observations indicated high temperature of the surface, however their interpretation was not quite unambigous. Some scientists assumed, that higher intensity of radio noises, ensuing from venus, is caused by some electric processes in the atmosphere. Therefore the direct experiment, conducted by descending vehicle, is of the utmost significance for clarifying the actual picture.

The cartridges of gas-analyzer were filled with sample of atmosphere at two levels of altitude. Directly after opening of the parachute the atmosphere sample was put into five cartridges. Into the other six cartridges the sample was put 347 seconds after the start of parachuting. After the input of samples the gas-analyzer cartridges were hermetically closed. In each cartridge was placed an active absorber, which absorbed one of the chemical component of the atmosphere, which made it possible to determine the content of this component from the pressure drop in the cartridge.

All the analyzers operated. They have shown, that carbon dioxide is the main component in the atmosphere of venus and composes at least 90-95% of the total composition. Analyzers with threshold sensitivity of seven per cent did not record presence of nitrogen. Percentage content of oxygen was found to be about 0.4%, and of water jointly with oxygen - not over 1.6%.

The t 'erature sensors were estimated for measuring temperature of ambient gas from 0°C to 400°C. The pressure was measured by an ordinary aneroid barometer. Density meter had a range for carbon dioxide ffom 5.10^{-4} to $1.7.10^{-2}$ gram in cu. cm.

The action principles of density meter is based on ionization of atoms and molecules of gas in the sensor by fast electrons, built-up by a source of beta-radiation, and the intensity measurements of ionic current, which is the density function of a atmospheric gas. The equipment operated continuously until the terminationof radio-signals reception from descending vehicle. Analysis of gauging results enables to draw conclusion, that the atmosphere of venus is characterised by high pressure, density and temperature.

Data of scientific measurements, conducted by "Venus-4", are being studied in detail and confirmed. The results of subsequent analysis will be published in scientific journals.

The successful flight accomplishment of the automatic station "Venus-4" to one of the most interesting planets of the solar system and implementation of the most difficult scientific experiments is a new Soviet technological breakthrough, showing unprecedented rise of science and technique in conditions of socialism. This is one more brilliant proof of the successful implementation of the majectic program of communism building, outlined by the XXIII Convention of the Communist Party of the Soviet Union.

The flight of the Soviet station "Venus-4" resolved one of the most difficult technical problems of interplanetary communications, which opens a new page in the mastering of circumosolar space and planets.

The unique scientific data, obtained by the "Venus-4" station, are a most important contribution to universal science.

The new victory in space is a marvelous present of the Soviet scientists, engineers, technicians and workers of all organisations, participating in development, construction, launching and controlling the flight of automatic station"Venus-4", for the fiftieth aniversary of the Great October, the report on their work to communist party and to Soviet people.

"Pravda", 22nd October 1967.

PRESS-CONFERENCE, DEALING WITH THE SOVIET AUTOMATIC STATION "VENUS-4":*

Yesterday in the Conference Hall of the Presidium of the Academy of Sciences USSR a press conference of Soviet and foreign journalists was held on the flight of the Soviet automatic station "Venus-4". The whole world was enraptured by the new feat of the Soviet Union, due to which the thick shroud, surrounding the planet Venus, is opening out in front of the whole mankind. This is why the press-conference was of so much interest to the gathering. The fact is, that here for the first time information will be disclosed, unknown to mankind till now.

In his address M.V. Keldysh disclosed that on the 18th of October 1967 Soviet automatic station "Venus-4" has reached the planet venus after a four-months flight. The descending vehicle of the station smoothly descended in the atmosphere of this planet. The "Venus-4" station provided a lot of valuable information on the interplanetary space, on the properties of the outer space in the vicinity of Venus and for the first time enabled gauging of the planet's atmospheric parameters. This is a new great step in the research of Solar System planets.

Venus is the planet nearest to earth in the Solar System. In 1961 M.V. Lomonosov discovered atmosphere at Venus. The planet is shrouded by a thick cloud cover, which does not permit to see its surface. This hampered the study of Venus, and upto now a lot in its nature remained mysterious.

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* The material of the press-conference is printed with abbreviations (Ed.).

Only quite recently Soviet and American investigators determined by radar methods the rotation period of Venus. It was found to be approximately 230 days. And the direction of rotation - opposite to that of earth/terrestrial. Radio-methods have provided lately a number of data on the temperature of the atmosphere, however, the interpretation of the obtained data was not unambigous and gave birth to various hypotheses.

Actually, remarked M.V. Keldysh, there were no experimental data whatsoever regarding pressure on the planet's surface. The values mentioned were from one to hundred atmosphere. Various assumptions were put forward about the chemical composition of Venus. It was expected, that concentration of carbon dioxide here is higher, than on earth. However, the estimates of its content varied within a very wide range - from few to almost hundred per cent. The first step in the investigation of planet was the study of the properties of its atmosphere. The problem of descent in the atmosphere of Venus was very difficult and required construction of a vehicle, adaptable to wide range of possible conditions. In determining the problems of experiment we assumed, that great success will be even in the case, if we could pass even a portion of the atmosphere in descent trajectory, since the deviations from calculated values could be tens of times.

Throughout the descent trajectory we steadily received from the station clear radio-signals. It must be said, that the problem of radio-transmission from the atmosphere of Venus also concealed a lot of new and unknown quantities. Power supply could only be provided by the storage batteries, since the illuminance was unknown under the cloud layer of the planet. Moreover, basing on conditions of radio-visibility, the station had to descend on the night side. Considering, that in difficult atmospheric conditions it might not have reached the surface, the whole information had to be quickly transmitted directly, without memorising. This made it necessary to construct equipment with strong emitting signals and to build rationally the whole system of recording and transmitting of information.

The dimensions of the station and the required power of emission determined maximum time of its work - 100 minutes, which seemed sufficient for gauging the parameters of atmosphere at various altitudes.

The station descended by means of parachute system. There were great difficulties also in the construction of a parachute. Thus, it had to be designed for working in temperatures upto 400°C.

Then M.V. Keldysh spoke of the technique of correction and trajectory measurements on the route earth-venus. Scientific gauguing was carried out throughout the flight of the station in the interplanetary space. It was memorized and transmitted to earth during the radio-communications.

Specially interesting was the near-planet session, when the results of scientific gauging were transmitted starting from about 40 thousand km from the Venus till the entry into its dense atmospheric layers.

The station entered into atmosphere of Venus at escape velocity. Uptill now not even a single space object has entered at escape velocity even into the well-known atmosphere of earth. The descending vehicle decelerated in conditions of enormous overstrain approximately from 11000 to 300 m per second, thereafter the braking was continued by parachute system. The parachute system was activated by barometric sensor, tuned to a certain pressure, independently from the timer.

We look on this experiment, said in conclusion M.V. Keldysh, as an outstanding contribution into study of the planet Venus and as the most important step on the way to interplanetary flights. The success of this most difficult experiment proves high development of science and technique in our socialist country.

The next speaker was V.E. Ishevskii, candidate of technical sciences, who read a paper on the construction of "Venus-4" station.

The "Venus-4" station consists of two main sections: orbital compartment and descending vehicle.

The orbital compartment is the main carrying element of the station's construction. It carries correcting propulsion system, sensors of scientific equipment, antennas, electronic-optical sensors of the orientation system, solar batteries and jet microrockets.

The pressurized capsule of the orbital compartment contains electronics of the various systems of the station, power sources and units of the thermal control system.

The active thermal control system retained the prescribed thermal conditions within plus 15 to plus 25^{o}C.

The construction of descending vehicle of "Venus-4" station involved resolution of principally new technological problems.

The descending vehicle is made in the shape of almost a sphere about one meter in diameter. Weight of the vehicle is 383 kg. The pressurized compartments contain various devices and units. The outside of descending vehicle is covered with a special heat insulation, which is concentrated mainly in the frontal part of the vehicle. It protects the vehicle from aerodynamic heating.

The main equipment and elements of the station's systems were doubled. The control circuits provided for switching over of duplicating sets in the case of failure of the main one. However, all the systems of the station worked normally and there was no need to use the duplicating sets.

A month before the approach to Venus, after confirming the place and time of entry into the planet's atmosphere, an automatic program was transmitted to the station for the near-planet session.

This session begun on the 18th of October 117 minutes prior to separation of descending vehicle from the orbital compartment. The separation took place at 7 hrs 34 min Moscow time.

On the 18th of October at 7 hrs 39 min Moscow time the earth began to receive the first radio-transmission of its ambassador from another planet of the Solar System.

At 9 hrs 14 min Moscow time the communication session with descending vehicle of "Venus-4" station has been completed after implementation of research program of the Venus atmosphere.

Then spoke Mr. S.N. Vernov member of the AN SSSR.

During the flight of "Venus-4" measurements were conducted on high and low-energy charged particles, magnetic fields and ultraviolet radiations, dispersed by hydrogen and oxygen atoms.

During the approach of the station to Venus the measurements were continuing on particles of various energies. This enabled to clarify, that there are no radiation belts in the vicinity of Venus.

As regards the magnetic fields, according to "Venus-4" data, they compose about seven gammas. According to measurements of "Venus-4" there are magnetic fields also of higher intensity. The moment of their appearance coincides with index changes of magnetic activity on earth.

Now the effects are being studied, which are connected with disturbance by Venus of the interplanetary plasma and magnetic field. The analysis of obtained data makes it possible to draw conclusion, that the magnetic dipole moment of Venus cannot be more than three over ten-thousandths of magnetic dipole moment of the earth. The investigation results of the Venus ionosphere contradict the previous assumptions.

The interplanetary automatic station "Venus-4" carried equipment for recording the ultraviolet radiation of the sun, dispersed by hydrogen and oxygen atoms. Density of the neutral hydrogen in the interplanetary space composes 0.01 atom per cu.cm. The device, recording radiation, dispersed by oxygen, has shown no rise in the intensity, which indicates non-presence of oxygen in the upper atmosphere of Venus. As regards the neutral hydrogen, its density in the vicinity of earth is 100 times higher, than on Venus. All this, said the scientist, permits to draw conclusion on the presence on Venus of dense molecular atmosphere, rather suddenly changing into interplanetary space. This , apparently, refers to the night half of the planet, which becomes its own type of "cemetery" for the charged and elementary particles.

Another speaker was A.P. Vinogradov. He emphasized, that the atmospheric temperature of Venus has been for the first time gauged directly. It varied from 40 to 270°C. The pressure varied on an average from 0.7 to 20 atmospher. Those are important characteristics of the Venus atmosphere.

The descending vehicle of "Venus-4" carried 11 gas-analyzers of carbon dioxide, water, acid and nitrogen. Composition determination of the Venus atmosphere was made at two levels: the first determination - at pressure of the external Venus atmosphere of 520 mm and temperature of about +40°(± 10°)C and the second determination - at pressure 1500 mm and temperature +80(± 10°)C.

The content of carbon dioxide was found to be 90%. Content of water or moisture - over 0.1% and less than 0.7%. The analysis of all data on water has shown, that the lower atmosphere of Venus is not saturated by water vapours. The water is condensed in the cloudy layer of Venus.

The content of oxygen is about 0.4-08%. Finally, of nitrogen the content is less than 7%. Probably, argon and other inert gases are present in small quantities in the atmosphere of Venus.

Only on earth, said the scientist, water and carbon dioxide are in the earth crust, in other words, the atmosphere is "buried", being under our feet, whereas, on Venus it is above the crust. In this case due to the nearness of the planet to the sun there is as though automatic "overturning" of the atmosphere. As a result an aggressive oxidative atmosphere has formed on Venus. The oxygen has oxidized rocks. Due to the loss of hydrogen there is "drying" of Venus, the surface of which could be imagined as a hot stony desert, colored by ferric oxide. There are processes of deep weathering of rocks, levelling of the stony relief of Venus.

Professor V.K. Prokofiev introduced journalists to data on the physical condition of the Venus atmosphere.

The atmosphere of Venus consists almost totally (90-95%) of carbon dioxide, whereas the amount of nitrogen does not exceed 7%. This, said the scientist, corrects to a considerable extent our concepts: the main component of the atmosphere is carbon dioxide, and not nitrogen. The presence was fixed of a small quantity (0.4-0.8%) of molecular oxygen and about 1% of water vapours.

A.M. Obukhov, member of the Academy of Sciences USSR, compared physical conditions on the two neighboring planets - on Venus and on earth. The general laws of physics of the atmosphere of planets are in principle the same, but each planet has its own specifics (so far we can compare conditions on Mars, earth and Venus).

The enormous significance has the fact, that key characteristics were obtained of the Venus atmosphere: chemical composition, thermal conditions and the general mass of the atmosphere.

The weather on Venus is "cloudy, but without precipitation". But of what the clouds consist, how great is their vertical thickness - we are only now making an approach to resolving this problem.

Now, after obtaining the first direct data on the atmosphere of Venus, concluded A.M. Obukhov in his address, a great and extremely interesting work is forthcoming of plotting a coordinated picture of the physical processes in the Venus atmosphere with the use of all the available data.

"Pravda", 31 October 1967.

WHY DO WE STORM THE SPACE:

Why do we storm the space? Are the efforts of the best scientists and engineers of the planet, financial expense warranted? What will the mankind receive in return? These questions are progressively more often asked in the press of many countries and, probably, even more often in conversation of people.

The man's penetration into space is a natural and logical step. Following the conquest of the water space and air the mankind should have inevitably begun the storming of the outer space, through which rushes our earth. The space elements play not less an important role in the life of the planet, than the water and air elements, and its conquest will, undoubtedly, be of great significance. And we have the right to be proud of the fact, that it is precisely our country which has opened the space era.

First of all the space technique opens out the possibility to start anew the study of our planet. Even the first satellites made it possible to determine with higher accuracy the shape of earth, which would have required many-years work by ground means.

Developed by means of space vehicles enormous significance have the works on the study of the upper atmospheric layers of earth, and specially of its inter-relation with activity of the sun.

Measurements, conducted during the flights of satellites, space probes, vehicles, shot to the moon, Venus and Mars, as though extended the limits of the earth's effect in the universe and drawn a majestic picture of the stream-lining of our planet's magnetosphere by gusty solar wind, consisting mainly of protons, electrons and having a speed, greater than the sound speed in this gas. Interaction of this wind with magnetic field of earth creates a pattern, similar to the stream-lining of a blunt body, rushing at supersonic speed in gas, when a shock wave is formed - norrow region of increasing concentration of particles and their temperature. The gigantic shock wave on line, connecting center of the sun and the earth, is at a distance from our planet of 8-9 of its radii. Region, encircled by this wave, stretches out in direction from sun, forming as though a trace of earth. It extent is still unknown, but the moon in its revolution around the earth intersects it, as was fixed in the flight of our lunar satellite.

Between the shock wave and the earth regions are detected the particles of higher concentration of particles, the so called radiation belts. Under the effect of the solar wind gusts or changes in corpuscular radiation of the sun the boundaries are changed of magnetosphere, density of particles in radiation belts, composition and density of the upper atmosphere of the earth, there are magnetic storms, northern lights and the connected disturbances in radio-communication. Study of the numerous mechanisms of interaction of corpuscular streams, electromagnetic radiation of the sun with terrestrial magnetosphere and atmosphere is as yet far from complete. Even less comprehensible is the mechanism of the phenomena, taking place on the sun itself, which result in intensity variation of corpuscular streams, magnetic fields and electromagnetic radiation. But the new facilities for investigations promise such progress in this sphere of the science, that in the near future, apparently, it will be possible to predict in advance variations of magnetic field and changes in climatic conditions.

The facilities of space technique, capable of providing information on the short-wave radiation of the sun, which does not reach the ground stations, jointly with perfection of mathematical methods will, apparently, permit to construct a complete theory of the evolution of climate of the earth and will make it possible to predict years ahead the meteorological conditions, to forecast drought-afflicted years or years of excessive humidity. It is not excluded, that it might become possible to actively influence the climate in some individual places.

Only the advance prediction of the coming of drought-afflicted year will provide economy, considerably in excess of expenditure on development of space technique. Besides the intensive study of solar-terrestrial bonds and of distant surrounding of earth, it will be possible be means of meteo-satellites to build up an effective system of short-term weather forecasting. According to estimates of American economists, a reliable weather forecasting for five days will economise billions of dollars per year. This is on the question of profitableness of space research, on what may give best comprehension of the effect of space elements on our planet.

The main result of the man's exit into space should be the appearance in a man's hands of new means and possibilities of scientific research and cognisance of the Universe. However, great may be the significance of the practical application of the space technique, for instance, for the construction of meteo-satellites, communication satellites or navigation satellites, but the main importance is the new means of scientific research. Speeding-up of the man's cognisance of the universe by means of the space technique may appreciably change the whole course of the mankind's history.

Astronomy is, probably, the oldest of the sciences. In the history of human civilization it alwasys had a great effect on the development of the world's outloook, simultaneously satisfying a number of the man's practical needs - navigation, time service, etc. Satellites and rockets today transform the aspect of this most ancient science.

Even at the start of our century it seemed impossible to see the other side of the moon, a celestial body - marest to us in the space. This was given as an example of unsolvable problem. But only two years after the launching of the first satellite the Soviet station "Luna-3" took pictures of the other side of the moon. Now we have the possibility to obtain maps of the moon, almost as detailed as the maps of earth. On pictures, transmitted from aboard the lunar stations soft-landed on the moon, it is possible to distinguish details of about one mm in size. Lunar satellites, vehicles sent to Venus and Mars, enabled to make a number of fundamental discoveries.

Rockets, carrying instruments beyond the atmosphere of planet and magnetosphere, permit to overcome also the main weakness of the terrestrial astronomy - impossibility to observe from earth the spectrum regions of electromagnetic waves shorter then 3000 angstrom, which are totally absorbed within the thickness of the air envelope. In front of our eyes are being born new trends of the ancient science - X-ray astronomy, gamma-astronomy observations are being conducted within the whole spectrum ofradiations, sent out by the Universe. We see only the beginning of this revolution, but even the first humble results speak of the fact, that this upheaval in the technique of research will provide discoveries of paramount importance.

New possibilities are being opened out by space technique for the present day physics. Accelerators, constructed on earth so far permit to obtain particles with energies of tens of billion electron-volts. These are exceptionally composite and costly erections. There are particles in the outer space hundreds of thousands, million times higher. The modern carrier-rockets permit to carry out into space targets and instruments for recording these particles and study of their interaction with nuclei of any atoms. As shown by the first experiments on Soviet satellites "Proton" weighing twelve tons, this problem is quite practicable. The use of space technique may be a more rational way to develop research on physics of high energies, than construction of grand accelerators on earth.

An exceptionally great effect on the development of many branches of terrestrial science and technique the space technique exerts by the fact, that the new problems, brought forward by its development, force to find new approaches for their resolution. This in turn stimulates development of these branches, and as a result the progress of the whole science is accelerated and the technical resolutions, found in this case, are transferred also to other spheres of terrestrial technique.

A wonderful characteristic of a man is the ability to dream. And not only to dream, but he must attempt to make these dreams a reality. Our time is typical in that. The dreaming is not of individual people, but whole scientific groups. Substantiation of the dream, appraisal of its reality is their job. The result of their work is either the end of the dream, putting it into practice, or a birth of a new idea. Cosmonautics is one of the spheres, in which it would seem the impossible dream of travel to planets have played a not insignificant role in development of the most difficult technique, which is being perfected at unbelievable fast rate. And one may think, that a lot of what today is being considered a dream, tomorrow will become a reality.

On the 12th of April 1961 Yurii Alekseevich Gagarin was the first in the world to orbit the earth and tested the first spaceship "Vostok". His name, just as the names of the Soviet and American spacemen, who followed him, will for every remain in the history of mankind as a symbol of courage and daring. But the travel on rockets will in time become an ordinary affair. Remember, enormous courage was required also of people, who flew on the first planes.

The velocity of spaceship in circumterrestrial orbit is considerably greater than the velocity of even supersonic planes. Flight into space removes the question of protecting sheathing, instruments, crew and passengers of the ship against the heat flux, inevitable with movement at high speed in the atmosphere. The problem on the way of space liners are the takeoff and descent.

The first cosmonauts flew on ships, in which the major part of enormous velocity was quenched due to braking in dense atmospheric layers. They had to experience considerable overstrains. Around the spaceship originated a layer of gas, temperature of which considerably exceded temperature of the sun's visible surface. This system of landing cannot, of course, be applied for a regular passenger travel. But there is a possibility of constructing vehicles, where the braking will be realized by engines according to prescribed program which does not permit high overstrains even in such rarefied layers of atmosphere, where the heating of ship will be insignificant. Spaceship, which has reduced velocity to near-sonic, may change-over to gliding or to helicopter-type of flying, and land in a small area close to a big inhabited center or even in the town itself.

In one of the methods for takeoff, it is possible to imagine a large vertical platform with air-jet engines, the task of which is to lift the ship to sufficient height so as to start the rocket engines without any fear.

The rocket system may provide for delivery of passengers to the other side of the Globe (15,000-18,000 km) approximately in one hour and may be found more safe and economical, than the service line of supersonic air-liners. True, the aviation has not as yet said its last word.

It may be more convincingly asserted, that with perfecting of technical facilities for penetration into space there will be a gradual settling of the surroundings of our planet by "long-living" space stations, both automatic and with the crews aboard. They will communicate with earth by means of lighter vehicles, delivering into space all the necessities and shifts of personnel. The main designation of these stations initially will be, of course, continued research of earth and of the Universe. They may carry on observation of the air element, oceans, crops and forests of the continents, thereby functioning as the global inspection. Through the network of these stations a system could be provided of communication and navigation. The possibility is not excluded, that it will be rational to use these stations also for some industrial purposes, such as for instance the use of the deep vacuum, which is so difficult to obtain on the earth's surface.

It is possible to set up long-term observatories on the moon with observers, who have the means for communicating with earth.

Further penetration of a man, primarily to the nearest planets - Mars and Venus, and thereafter to even more distant ones will have the main object of cognition. It is already possible to imagine the development of technical facilities of this advance. Initially, of course, automatic stations, thereafter expeditions on inhabited spacecrafts. The difficulties facing the technique on this path are great, but not unsurmountable.

The day is not far, when the most exciting mystery will be resolved and we will get the answer to the question, whether there is life outside the earth and what are its forms. The resolution of this question will be of enormous significance for the mankind and will determine, to a considerable extent, the rate and the ways of further conquest by a man of our Solar System. What are these ways? What should be understood as the conquest? Initially, of course, the research, but what after? Even at the turn of the century the great Russian thinker K.E. Tsiolkovskii wrote about the spaceships-planets, getting their energy from the sun and not needing any additional power supply. This kind of spaceships may become reality and in time make us feel at home in space.

Development of the space science and technique may take the way also of mastering other planets. The means can be imagined, with the help of which it will be possible to change the conditions on Mars and Venus as desired.

Even now the way may be pointed out for changing to a considerable extent the climate of earth or Mars by increasing the amount of solar energy, received by the planets. By means of rockets it is possible to create a dust ring around the planets so, that the incoming and outgoing rays of the sun would be partially dispersed on the dust particles and would be in some measure reflected to earth and Mars, increasing thereby the share of the solar energy received by them.

Only ten years have passed since the first experiment, which opened the way into space for a man, and less than even years since the day of the first man-in-space flight. But during this interval, insignificantly short in comparison with the history of civilization development, the mankind has acquired hands, capable of stretching to millions of km from its cradle, and quickly learnt to use these hands; acquired new eyes, capable of seeing what was for many centuries hidden from a man, and acquired a new idea, capable of uniting the thoughts of the people of the whole earth.

The mankind has entered into a new brilliant era of its development. The intelligent man of the earth is coming out of its cradle and takes possession of the Solar System.

G. Petrov, Director, Institute of Space
Research of the Academy of Sciences USSR.

"Izvestiya", 3 October 1967.

THE BEGINNING OF THE SPACE ERA:

On the 4th of October 1957 a rocket ascended from the territory of the Soviet Union, which has placed into orbit the first artificial earth satellite. Our Motherland has opened wide the doors of the Universe for the mankind. On this day due to the genius of Soviet scientists, creative work of our engineers, technicians and workers the space era has set-in for the people of the earth.

Yesterday thousands of Moscovities have come to the Kremlin Palace of Conventions. A meeting took place here, devoted to the tenth anniversary of launching in the Soviet Union of the first in the world artificial earth satellite.

All the present warmly greet the appearance in presidium of comrades A. Ya. Pelshe, M.A. Suslov, A.N. Shelepin, V.V. Grishin, D.F. Ustinov, I.V. Kapitonov.

Jointly with them took places in presidium our famed cosmonauts. The meeting is opened by V.F. Promyslov, Chairman of the executive committee of Moscow Council. M.V. Keldysh is asked to give a report.

— The first decade of cosmic era, - he said, - we mark on the eve of the great festival of our people and of the whole progressive humanity - 50th anniversary of the Great October Socialist Revolution. The opening of the space flights era is one of the greatest achievements of mankind.

The foundation for the development of the scientific theory of the space flights was laid by Tsiolkovskii. During the 20s - 30s a group was formed in the Soviet Union of outstanding designers and scientists, who ardently believed in the possibility of realizing the ideas of space flights and worked persistently on their development and putting them into practice. Their initiative was supported by the Communist Party and the Soviet Government. Development of rocket technique has played a big role also in defence of the Motherland. Tactical rockets, widely known under the name of "Katyusha", was a formidable weapon during World War II. Now the ballistic intercontinental rockets, constructed for the first time in the Soviet Union, reliably ensure the peaceful building in our country. During the post-war years we have accumulated such an experience in the sphere of the rocket technique, that for a daring technological thought a real possibility has opened out for space flights.

The first artificial satellite, which marked the entry of mankind into space era, proved the possibility of accomplishing space flights, has strengthened the confidence of correct choice of the ways for resolving various and difficult technological problem connected with it. During the previous years hundreds of space vehicles were placed into earth orbit.

Investigations on satellites, as well as on space rockets have appreciably changed our concepts of the circumterrestrial space, defined the most intense bonds between the processes, which take place on the sun and in the vicinity of the earth. This is of enormous significance for understanding and development of forecasting meteorological phenomena, study of the propagation laws of radio-waves, flight control of space vehicles in the vicinity of earth. It is only due to investigations on satellites, that we have now a sufficiently complete picture of the upper layers structure of terrestrial atmosphere, including its ionized regions - ionosphere, which determines the conditions of short-wave radio communication.

One of the most brilliant results of research on satellites was the discovery of the radiation belt of the earth. In the study of physical processes throughout the extent of the radiation belt in 1964-65 by means of satellites "Electron" a lot of new information has been obtained. In particular, spectra of electrons and protons were obtained asymmetry of the radiation belt on the day and night sides was investigated.

Our concepts were verified to a considerable extent on the structure of the earth's magnetic field, including at considerable distance from the surface, upto the boundary of magnetosphere. The existence of new geomagnetic anomalies was defined. An extensive program was carried out on the universal magnetic survey.

During the last few years it was clarified, that the earth is constantly "blown" by the solar corpuscular streams - by "solar wind". This continous flux of plasma deforms magnetic field of the earth at great distances, and the lines of force, coming out from the polar regions, deflects to the night side. These lines of force and bound with them plasma form the so called magnetic trail of earth.

M.V. Keldysh mentions investigations, carried out by means of heavy satellites "Proton" with a record total weight of 12.2 tons. This made it possible to take out beyond the limits of atmosphere multiton equipment and thereby opened out great possibilities for the physics of elementary particles of high and superhigh energy - upto energies of tens of thousands billion electron-volts, inaccessible even to the most powerful modern accelerators. On the three "Proton" satellites new experimental data were obtained, necessary for resolving principal problems in physics of elementary particles of high energies and for the study of the nature of cosmic radiation.

The speaker goes on to say, that the most important step in space research became the accomplishment of manned-space flight. The heroic feat of Yu. A Gagarin is included in history for ever. The mankind will never forget the great service of the galaxy of scientists and designers - followers of K.E. Tsiolkovskii, primarily the Academician Sergei Pavlovich Korolev, in the construction of the first artificial earth satellite and in subsequent development of space-rocket technique, who assured to our country the priority in the main stages of research and conquest of the outer space.

The flights on spaceship-satellites open out grand prospects. A possibility is being provided for a fast communication on earth. As we know, during the last decade the aviation was developing on the line of persistent increase in the velocity and altitude of flight. This was of enormous significance in the improvement of aerial communications. Now the onset is of a new stage - the construction is of supersonic passenger planes, which will cover the distance between continents considerably faster, than the present air-liners. However, the rocket transport provides for even greater rise in velocity of flights. It will permit in less than an hour to cover distances between the most remote areas of the Globe.

The most extensive possibilities for science and practice will be provided by the construction of permanently inhabitable orbital stations for research in the spheres of astronomy, geophysics and meteorology, for radio-broadcasts, television, navigation. The possibility will be assured for a man's prolonged staying at these stations. He will be able to fly up to the station and to return from it to earth.

Finally, the majestic prospect of interplanetary flights, a man's visits to other planets, possession of new still unknown riches of nature. To accomplish a man's flight to other cosmic bodies - interplanetary flights many difficult scientific and technical problems will have to be resolved.

During the ten years a lot has been done toward accomplishing distant flights of automatic space vehicles. Thereafter M.V. Keldysh speaks of the first Soviet space rockets, shot for the lunar research, including that, which for the first time orbited the moon and photographed its other side. In our country the achievement of escape velocity opened a new major stage of automatic station's flight beyond the sphere of earth's attraction, into the interplanetary space of Solar System.

Since 1960 the flights were being accomplished of interplanetary space vehicles to Venus and Mars. The flights of distant space rockets, including several special probes, produced a lot of new data on the interplanetary space. It was defined, that the interplanetary space is not empty, although the matter within it is extremely rarefied. Intensive physical processes take place within it, many of which are bound with plasma of the solar wind. Individual clouds of plasma, generated by the solar flares, during which the corpuscular radiation of the sun considerably increases, cause magnetic storms on the earth. These clouds carry with them magnetic fields. The rarefied hydrogen fills the whole of the outer space. From distant regions of the Universe are incoming cosmic rays. The Solar System is pierced by numerous showers of meteors. The space rockets enabled for the first time to record directly all these processes and to detect new phenomena, which play an important role in the development of our concepts regarding the Universe.

Interplanetary automatic stations jointly with the new facilities of ground observations made it possible also to obtain new information on the planets Venus and Mars. We know now, that the magnetic fields of these planets are several orders lower, than the magnetic field of earth. The American station "Mariner-2" took pictures of some areas on the surface of Mars which have shown, that the surface of this planet is covered by numerous craters, similar to lunar craters. New data were obtained about the atmosphere of these planets. However, a lot has to be done still, to uncover the secrets of Mars and Venus planets.

For instance, we still don't know the depth of atmosphere under the surface of the cloud layer of Venus and, therefore, the radius of this planet. There is more information about Mars. However, even here many basic questions remain unanswered. We know n nothing about the composition of the planets matter and their internal structure. One of the most exciting questions is whether there are some life forms outside the earth, and mainly on planets Mars and Benus. Distant planets of the Solar System conceal even more mysteries.

One of the most important stages in the research of Solar System will be the landing of automatic vehicles on other planets, and primarily on Mars and Venus. This will require resolving of a large number of new scientific and designing problems.

The outstanding achievement of the Soviet science and technique in the development of space research was the "soft" landing of the automatic station "Luna-9" on the lunar surface. By means of the station "Luna-9" a man have seen for the first time the lunar landscape in its direct vicinity. On T.V. pictures, transmitted by the station, it is possible to distinguish details a few mm in size. The lunar surface showed no visible traces of dust. It was found to be quite hard. Automatic station "Luna-13", which accomplished the "soft" landing in December of 1966, extended our knowledge even more. The equipment aboard the station enabled to obtained a number of valuable data regarding density of the lunar soil and its mechanical properties, to come to conclusion, that the moon has low radioactivity.

These investigations have shown the actual possibility of constructing on the moon of automatic laboratories for systematic astronomical and physical research.

On the 3rd of April 1966 the first artificial satellite - Soviet automatic station "Luna-10" - was placed into lunar orbit. A great volume of research was conducted on Soviet lunar satellites, direct recording accomplished of various types of radiations, characterising physical and chemical properties of lunar surface, study was made of the moon's attraction field. Investigations of the natural radio-active emission enabled to come to conclusion, that lunar rocks are similar in their properties to basalts, and to exclude the presence of large granite massives. This fact is of high scientific significance.

Space research has opened enormous prospects in the study of earth, planets, interplanetary space, in the development of science about the Universe. At the same time we are witnessing practical application of results from space research, which become the property of the whole mankind. Wide prospects have opened out for development of communication, weather forecasting, improvement of navigation, ionospheric service and sun service. The use of satellites for radio - and television communication is rapidly becoming a universal practice. For this object the Soviet Union has constructed communication satellites "Molniya-1".

By means of the "Molniya" satellites programs of Central television are being received in many sibirian and Far-East towns. In future the construction will be of satellites, which will provide reception of T.V. transmissions directly on the household televisors. This will enable to receive T.V. transmissions directly from satellites in any area of our country. The satellites will play a major role in the building of universal space communication.

All, that our country has achieved during the last decade in the sphere of research and mastering of space - said in conclusion M.V. Keldysh, - was provided by our socialist order, selfless labor of workers, engineers, scientists, attention of Communist Party and of the Soviet Government to this work. The feat of our people, who paved the way into space, is of the most outstanding events not only of the twentieth century, but of the whole history of mankind.

"Pravda", 5 October 1967.